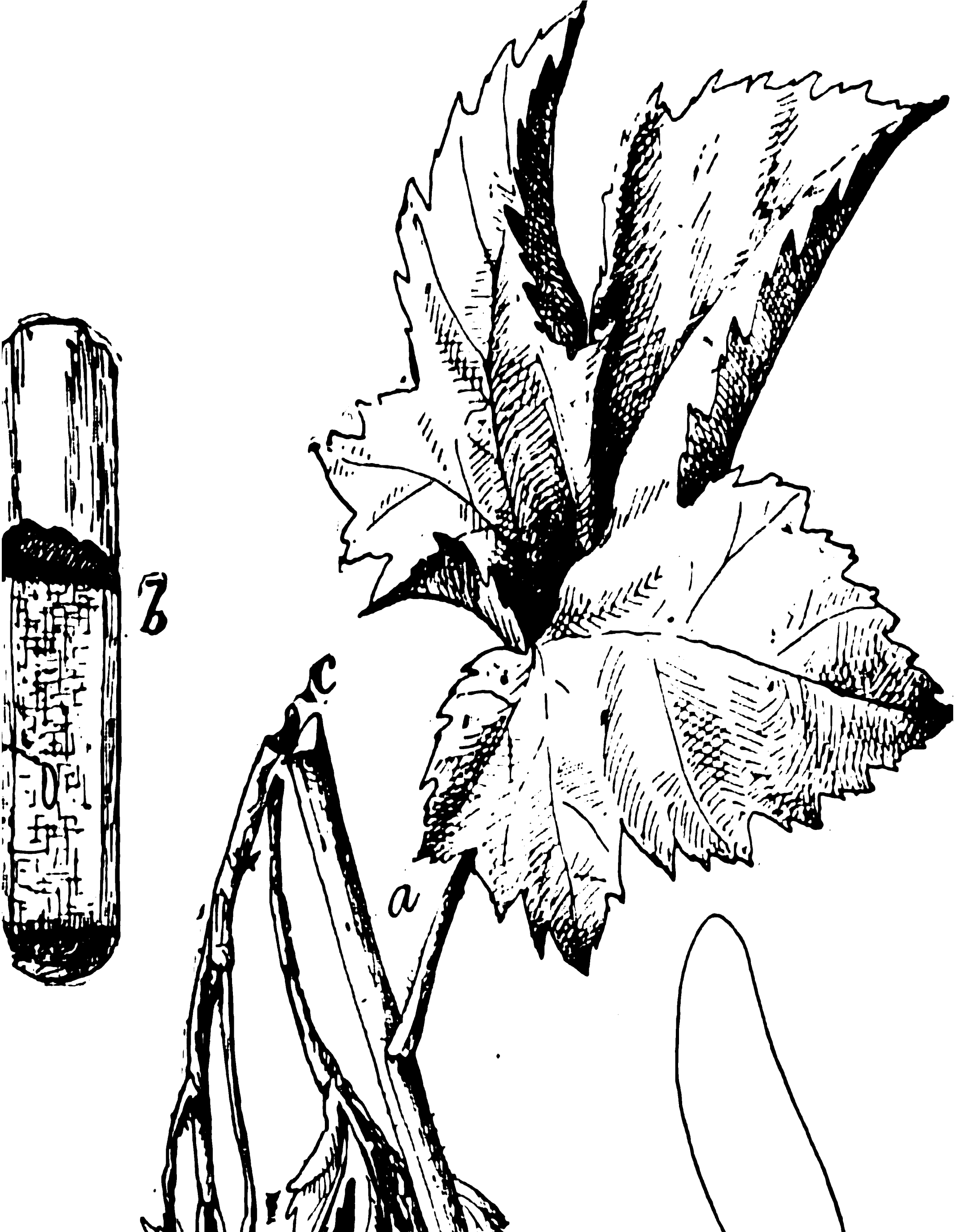

Annual report of the secretary of the Connecticut Board of Agriculture

Connecticut. State Board of Agriculture

Presented by

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State of Connecticut

THIRTIETH ANNUAL REPORT

OF THE

SECRETARY

OF THE

Connecticut Board of Agriculture

1896

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1897

To the Governor of the State of Connecticut:

In accordance with the provisions of the Act creating a STATE BOARD OF AGRICULTURE, I have the honor to present the Report for 1896.

T. S. GOLD, *Secretary*.

WEST CORNWALL, December 1, 1896.

STATE BOARD OF AGRICULTURE.

1895-96.

HIS EXCELLENCY O. VINCENT COFFIN, *ex officio.*

APPOINTED BY THE GOVERNOR AND SENATE.

		Term Expires.
E. H. HYDE,	Stafford,	1897
THERON E. PLATT,	Newtown,	1897
F. M. BARTHOLOMEW,	E. Wallingford,	1899
J. F. BROWN,	N. Stonington,	1899

ELECTED BY THE AGRICULTURAL SOCIETIES.

Hartford County,	DUDLEY WELLS,	Wethersfield,	1898
New Haven County,	A. B. PIERPONT,	Waterbury,	1897
New London County,	CLIFTON PECK,	Franklin,	1897
Fairfield County,	NELLIS H. SHERWOOD,	Southport,	1898
Windham County,	W. H. HAMMOND,	Hampton,	1898
Litchfield County,	GEO. L. FOSKETT,	Winsted,	1898
Middlesex County,	SAMUEL A. CHALKER,	Saybrook,	1897
Tolland County,	JOHN THOMPSON,	Ellington,	1897

ELECTED BY THE BOARD.

T. S. GOLD, West Cornwall, *Secretary.*

OFFICIAL LIST.

GOVERNOR O. VINCENT COFFIN, *President.*

J. F. BROWN,	N. Stonington,	*Vice-President*
T. S. GOLD,	West Cornwall,	*Secretary*
F. M. BARTHOLOMEW,	E. Wallingford,	*Treasurer*
Prof. S. W. JOHNSON,	New Haven,	*Chemist*
Pres. B. F. KOONS,	Storrs,	*Entomologist*
Dr. E. H. JENKINS,	New Haven,	*Botanist*
N. S. PLATT,	Cheshire,	*Pomologist*

GEO. T. FOSKETT, CLIFTON PECK, DUDLEY WELLS,

Commissioners on Diseases of Domestic Animals.

N. H. SHERWOOD, S. A. CHALKER, JOHN THOMPSON,

Auditors.

REPORT.

To the Governor of the State of Connecticut:

A meeting of the State Board of Agriculture was held at the New Haven House, at the call of the Governor, December 16, 1895, at 8 P. M., L. J. Wells, vice-president, in the chair.

Present, also, Messrs. Bartholomew, Brown, Thompson, Foskett, Hough, Blakeman, Chalker, and Gold.

On motion,

Voted, That the annual meeting be held on the third day of January, 1896.

The Secretary reported a synopsis of report of Commissioner Hubbard on Peach Yellows; also change in programme, from inability of Mr. John Gould to meet his engagement, substituting as follows:

Hon. Wm. E. Simonds will explain the Torrens Land Title system; a discussion on Horticulture by Messrs. Platt, Britton, Phelps, Hale, and others.

The necessity was explained of obtaining another hall for Mr. Twitchell's lecture, where a horse and cow could be presented.

The matter was left with Mr. Bartholomew and Mr. Sanderson, and the Hyperion was secured free of charge from Mr. Bunnell, the proprietor.

The Secretary notified all members to have all bills presented to him previous to January first.

The Cattle Commission reported some facts concerning their work, followed by questions and answers in explanation.

The Board adjourned to the call of the Secretary.

NEW HAVEN, December 16, 1895.

The annual meeting of the Connecticut State Board of Agriculture was held at Room 50, Capitol, Friday, January 3, 1896, at 11 A. M., L. J. Wells, vice-president, in the chair.

Present, Messrs. Bartholomew, Chalker, Brown, Pierpont, Thompson, Foskett, Peck, and Gold.

Messrs. Bartholomew and Chalker were appointed a Committee on Credentials, and reported Messrs. W. H. Hammond of Hampton, Nellis H. Sherwood of Southport, and Dudley Wells of Wethersfield as members duly elected.

Mr. Brown was appointed as a committee to wait on the Governor and invite his presence. Mr. Brown reported that the Governor had not yet arrived at his office. Later in the meeting Mr. Rood, chief clerk, announced a telegram from the Governor that he had been unexpectedly detained by important business, and could not be present.

The Secretary reported, on good authority, that Mr. Foskett had been chosen as his own successor, and Mr. Foskett was chosen to fill the vacancy pending receipt of certificate.

Report of the Secretary was read, and the balance, a part having been previously accepted, was accepted.

Report of the Treasurer was read and accepted.

The Auditors reported and report accepted.

On motion of Mr. Brown, it was

Voted, That the Secretary and Vice-President be authorized to obtain a seal for the Board.

Mr. Foskett presented the report of the Cattle Commission, which was accepted.

Reports of Visiting Delegates at Fairs were presented by the Secretary and discussed by the Board. On motion of Mr. Hammond, amended by Mr. Brown, it was

Voted, That the Secretary withhold the State bounty from the Willimantic Fair Association until after having taken good legal counsel, to the effect that it is his duty under the statute to approve the payment.

A recess of one hour was taken for dinner.

Session resumed at 2.30 P. M.

The Board proceeded to choice of officers, Mr. Pierpont, teller.

His Excellency O. Vincent Coffin was chosen President by acclamation.

The official list was filled by ballot.

J. F. Brown, North Stonington, Vice-President.

T. S. Gold, West Cornwall, Secretary.

F. M. Bartholomew, East Wallingford, Treasurer.

Prof. S. W. Johnson, New Haven, Chemist.

Dr. E. H. Jenkins, New Haven, Botanist.

Pres. B. F. Koons, Storrs, Entomologist.

N. S. Platt, Cheshire, Pomologist.

George L. Foskett, Winsted,
Clifton Peck, Franklin, P. O. Yantic,
Dudley Wells, Wethersfield,
Commissioners on Diseases of Domestic Animals.

John Thompson,
S. A. Chalker,
N. H. Sherwood,
Auditors.

In some cases above an informal ballot was first taken. Mr. Pierpont was chosen as one of the Cattle Commissioners, but was excused at his own request.

W. H. Hammond was elected as Trustee of Storrs College for one year.

Voted, That the Secretary and three members appointed by the chair be Committee on Institutes.

Messrs. Hammond, Sherwood, and Bartholomew were appointed.

Committee on Winter Meeting was appointed, consisting of the Secretary, Vice-President, and members of Committee on Institutes, viz.: Messrs. Hammond, Sherwood, and Bartholomew.

Committee on allotting delegates to Fairs, Vice-President and Secretary.

The Secretary presented report of Peach Yellows Commissioner, which was read by title.

Voted, That the thanks of the Board be presented to the retiring Vice-President for his faithful service.

Voted, That the bond of the Treasurer be accepted, subject to the approval of the President, Vice-President, and Secretary.

The Board adjourned *sine die*.

WEST CORNWALL, January 3, 1896.

A meeting of the Connecticut State Board of Agriculture was held at the call of the Secretary, by authority of the Governor, at Room 50, Capitol, Wednesday, July 15th, at 1 P. M.

On motion, Samuel A. Chalker was chosen Chairman.

Present, Messrs. Wells, Pierpont, Peck, Sherwood, Hammond, Foskett, Chalker, Thompson, and Gold.

The Secretary announced the death of ex-Lieutenant-Governor E. H. Hyde of Stafford, June 18th, and presented the following resolutions, which were passed by the Board:

Resolved, That we desire to bear our testimony to the faithful service rendered to the cause of agriculture by our late associate, ex-Lieutenant-Governor E. H. Hyde. As long-time president of the State Agricultural Society and vice-president of this Board, he was unwearied in his efforts to promote progressive agriculture. Endowed by nature with a keen perception of beauty in animal life, in flower and fruit, he was always ready not only to enjoy these good gifts of Providence, but to encourage all efforts to secure for agriculture its appropriate reward as the foundation of all material prosperity.

Public service for over half a century had brought to him a wide circle of friends, not limited to our own State, who will mourn with us the loss of so honest and earnest a co-worker in the interests of agriculture and everything pertaining to rural life.

Resolved, That these resolutions be placed upon our records, and that the Secretary be instructed to present a copy to the family of the deceased, and to the press for publication.

A report from Mr. Hubbard, Commissioner on Peach Yellows, was presented by the Secretary, read, and accepted.

MIDDLETOWN, July 14, 1896.

To the Connecticut Board of Agriculture:

I respectfully ask the approval of the Board for the appointment of Mr. L. P. Smith of Lebanon, and Dr. C. F. Congdon of Salem, to be Deputy Commissioners on Peach Yellows for New London County.

Of those whose names are carried on last year's list of deputies, all have consented to serve this season except Mr. E. C. Warner of New Haven County, Mr. Clifton Peck of New London County, and Mr. Charles A. Sill of Middlesex County.

Messrs. Smith and Congdon are named to succeed Mr. Peck, whose district, in my judgment, can be handled to better advantage if divided.

No new names are presented in place of Messrs. Warner and Sill, as it is believed that the work in New Haven and Middlesex counties can be advantageously handled by those remaining.

If the appointment of Messrs. Smith and Congdon receives the approval of the Board, the full list of deputies will stand as follows:

HARTFORD COUNTY.— A. C. Sternberg, Jr., West Hartford; R. A. Moore, Kensington; J. C. Eddy, Simsbury; George F. Chapin, Thompsonville.

NEW HAVEN COUNTY.— J. Norris Barnes, Yalesville; Dennis Fenn, Milford; W. F. Platt, Milford; E. A. Todd, Waterbury.

FAIRFIELD COUNTY.— George C. Comstock, Norwalk; F. E. Blakeman, Oronoque; R. W. Holmes, Danbury.

LITCHFIELD COUNTY.— Ard Welton, Plymouth; H. G. Manchester, West Winsted.

TOLLAND COUNTY.— G. G. Tillinghast, Vernon; Myron W. Sperry, Bolton.

WINDHAM COUNTY.— L. H. Healy, North Woodstock; Lucien Bass, Windham; J. B. Stetson, Brooklyn.

NEW LONDON COUNTY.— James F. Brown, Jr., North Stonington; Henry W. Morse, Jewett City; L. P. Smith, Lebanon; C. F. Congdon, Salem.

MIDDLESEX COUNTY.— Robert P. Hubbard, Middletown; Henry J. Nettleton, Durham Center; Silas Payne, Cobalt.

FOR SPECIAL SERVICE.—A. C. Collins, Hartford; A. G. Gulley, Storrs; H. P. Smith, North Haven.

I have been very desirous of keeping the work for this season so far as possible in the hands of experienced men, for the reason that the general failure of the peach crop deprives us of one lasting

symptom of the yellows, and makes the task of its detection one of more than usual difficulty.

Of the new men named, Mr. Smith is an enthusiastic grower whose work in his own orchard is a voucher for good services elsewhere, and Mr. Peck certifies to Dr. Congdon's general and special qualifications for the position.

Concerning the regulations for the work, the only modification I would suggest is a change in the date set for its completion. I think it would be better to insert the date September 20th in place of August 20th, and also in place of September 15th, where the aforesaid dates occur in the paragraph relating to this matter.

I exceedingly regret my inability to meet with the Board on this occasion, and beg its members to believe that only the most imperative sense of duty elsewhere serves to keep me away.

Respectfully submitted,

J. M. HUBBARD,
Commissioner on Peach Yellows.

Voted, That the gentlemen recommended by the Peach Commissioner for his Deputies for the present year be approved.

In regard to the change of dates recommended by Mr. Hubbard, it was

Voted, That the date of August 25th, as standing in previous order for work of Deputies, be made September 1st, and the date of September 15th be made September 20th. With regard to the second visit of inspection the word "should" was changed to "shall."

The following addition was made to the rules governing inspectors:

Voted, That the Deputies be directed to mark the trees which they condemn by removing a portion of bark from the trunks where the tag is to be attached.

An application was made by Mr. Wilcox of Waterbury for release of cattle from quarantine, that he might exhibit them at fairs in the State. After discussion by the Board on repealing the privilege of exhibiting cattle at fairs in the state under quarantine, no action was taken, and the whole matter was left as before with the Commissioners on Diseases of Domestic Animals.

The Secretary called attention to the vacancy existing in the Board by the death of ex-Lieutenant-Governor Hyde, and, on motion, it was

Voted, That the Hon. William B. Sprague of Andover be appointed to fill out the unexpired term vacated by the death of ex-Lieutenant-Governor Hyde.

The Board then adjourned.

A meeting of the Connecticut State Board of Agriculture was held on call of the Secretary by authority of the Governor, at the Winthrop Hotel in Meriden, Thursday, September 10th, at 12 M., Colonel J. F. Brown of North Stonington, Vice-President, in the chair. Present, Messrs. Foskett, Pierpont, Platt, Peck, Thompson, Chalker, Wells, and Gold. The Secretary read the call of the meeting.

The Secretary presented the subject of election of a committee of experts to decide on appeals from decisions of Deputy Commissioners on Peach Yellows, and, on nomination, the following were elected :

Professor A. G. Gulley, Storrs; N. S. Platt, Cheshire; Professor W. E. Britton, New Haven. G. S. Butler of Cromwell was elected an alternate in case of any member being unable to serve.

The Secretary presented a plan for Farmers' Institutes prepared by Professor Phelps, and, after an amendment to Section 5, it was passed according to amendment, subject to approval of the Board at annual meeting.

Plan of Farmers' Institutes for 1896–97 by the Board of Agriculture in co-operation with the State and Storrs Experiment Stations.

1. Hold two Institutes in each county between November 1st and April 1st.

2. Speakers to be selected from the staffs of Experiment Stations, Professor Gulley of the College to be included with the staff of the Storrs station.

3. One, and but one, regular speaker shall be selected from each station for each Institute.

4. Incidental expenses, including printing and traveling expenses of speakers, shall be paid by the Board of Agriculture.

5. Management of Institutes to be under the control of a committee consisting of Committee of Board of Agriculture on Institute Work, and one member appointed by each station.

6. Two sessions shall be held at each Institute, and except where hotels or restaurants are convenient, a lunch shall be provided by the local organizations by whose invitation the Institute is held.

The Secretary presented the subject of rules and regulations for the control of contagious diseases of domestic animals, and Mr. A. B. Pierpont presented a set of rules for the control of diseases by the Commission, and moved that they be adopted by the Board.

The motion was seconded by Mr. Foskett and unanimously passed, adopting the following resolutions:

Resolved, That in the place of the quarantine regulations hitherto existing, the following rules and regulations are hereby adopted by the Connecticut State Board of Agriculture:

SECTION 1. For the purpose of preventing the spread of the contagious disease known as tuberculosis among domestic animals, in the judgment of the State Board of Agriculture, public safety demands that the introduction of neat cattle into this state from any other state or country should be prohibited. Therefore, by virtue of the power and authority vested in this Board, the introduction after the date hereof of any neat cattle into this state from any other state or country is hereby strictly and absolutely forbidden and prohibited, except as hereinafter provided.

SEC. 2. Parties desiring to bring cattle into this state for immediate slaughter must secure a permit to do so from the Commissioners on Diseases of Domestic Animals before shipping such animals. Upon arrival such animals will be held in quarantine until slaughtered, at which time the meat will be inspected by one of said commissioners, or their agents.

SEC. 3. Parties out of this state desiring to enter cattle for exhibition at the agricultural fairs within this state must notify said commissioners, who will give a permit to do so upon condition

that said cattle will be held in quarantine without expense to the state while here.

SEC. 4. The commissioners may grant a permit at their discretion to any person wishing to bring cattle into the state for sale or for his own use, subject to be tested with tuberculin by any person designated by said commissioners, upon his written guarantee to hold the same in quarantine as directed by said commissioners. All expenses connected therewith to be paid by the owner.

SEC. 5. No other neat cattle will be allowed to enter this state unless each animal is accompanied by a certificate of tuberculin test and a permit issued by said commissioners. Each certificate shall give a description of the animal sufficiently accurate for easy identification. It shall give the date when the tuberculin test was made, also state the preparation of tuberculin used, the quantity injected, the temperature ascertained immediately previous to injection and the temperature at the ninth hour and every two hours subsequent thereto, for a period of at least ten hours or until the reaction has been complete. The test shall be made and the certificate signed by a veterinarian whose competency has been certified to by a member of the cattle commission or other authority having jurisdiction over the suppression of contagious diseases among domestic animals in the state from which such animal is to be driven or shipped. Upon arrival, such animal will be held in quarantine until identified and released by order of said commissioners.

SEC. 6. No persons, party, corporation, or transportation company shall unload or deliver into this state any neat cattle, except such as are accompanied with a permit from said commissioners as provided in the preceding sections.

On motion of Mr. Foskett it was

Voted, That these rules, as adopted, be pasted in the record book by the Secretary, and that a certified copy of the same shall be published by the Secretary in the *Hartford Times* and *Hartford Post* each for five successive days, and that the Secretary shall preserve on file one copy of each issue.

The Secretary then read record of the meeting, which was approved.

Meeting adjourned.

T. S. GOLD, *Secretary*.

MERIDEN, September 10, 1896.

AGRICULTURAL FAIRS IN CONNECTICUT, 1896.

With Visiting Delegates.

Connecticut State, Sept. 9–11. J. F. Brown.
New London County, Sept. 22–24. W. H. Hammond.
Windham County, Sept. 23–24. F. M. Bartholomew.
Tolland County, Sept. 15–17. Clifton Peck.
Berlin, Sept. 23–24. Dudley Wells.
Branford, Sept. 22–24. N. H. Sherwood.
Bristol Park Assoc., Sept. 30. Dudley Wells.
Chester, Oct. 7–8. Samuel A. Chalker.
Clinton, Sept. 23. J. F. Brown.
Danbury, Oct. 5–10. N. H. Sherwood and Dudley Wells.
East Granby, October. John Thompson.
Farmington Valley, Sept. 9–10. George L. Foskett.
Granby, Sept. 2–3. Clifton Peck.
Guilford, Sept. 30. T. E. Platt.
Harwinton, Oct. 6. N. S. Platt.
Killingworth, Oct. 7. N. S. Platt.
New Milford, Sept. 8–10. N. H. Sherwood.
Newtown, Sept. 29–30, Oct. 1. John Thompson.
Simsbury, Oct. 7–8. William B. Sprague.
Stafford Springs, Oct. 6–8. W. H. Hammond.
Suffield, Sept. 22–24. T. E. Platt.
Union (Monroe, etc.), September. T. E. Platt.
Union (Somers, etc.), Oct. 1. Samuel A. Chalker.
Wallingford, September. George L. Foskett.
Watertown, Sept. 23–24. A. B. Pierpont.
Willimantic, October. A. B. Pierpont.
Windsor, September. F. M. Bartholomew.
Winsted, Sept. 15–16. A. B. Pierpont.
Woodstock, Sept. 14–15. William B. Sprague.
Wolcott, October. W. H. Hammond.
Connecticut Hort. Soc.* N. S. Platt.

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* April, June 10–11, about September 8, and about November 8–10.

FARMERS' INSTITUTES were held at North Stonington, Feb. 1st; Ekonk, Feb. 5th; Newtown, Feb. 15th; Waterbury, Feb. 20th; Hampton, March 5th; Southport, March 12th; Clinton, March 17th; Plainfield, March 21st; Washington, March 26th; Winsted, March 31st.

The speakers were generally from the two Experiment Stations.

The subjects presented were of a practical character, and a good attendance was secured.

We are pleased to note the improved accommodations and general arrangements furnished by the localities. This coming year we hope to hold an increased number, to meet the call as far as possible from all parts of the state, and our two stations will co-operate more directly with the Board in the work.

REPORT OF COMMISSIONER ON PEACH YELLOWS.

Mr. T. S. Gold, Secretary Connecticut State Board of Agriculture:

Sir: — The gentlemen whose names follow were duly appointed and confirmed as deputy commissioners on Peach Yellows for the season of 1896, and, with the one exception of Mr. Barnes of New Haven County, have taken part in the actual work of the commission.

I very much wished that Mr. Barnes should continue to act as deputy for the reason that his extensive experience in combating the Yellows on his own account, gave him exceptional qualifications for the work, and he reluctantly consented to accept the appointment; but it fell out, as he feared, that the imperative demands of his own business prevented him from giving any time to the work of the commission.

It is well known that one of the leading indications of the presence of Yellows is found in the appearance and condition of the fruit, and the almost entire absence of fruit from our peach orchards this year has made the detection of Yellows a matter of more than ordinary difficulty.

For this reason it was deemed especially important that the deputies should have the benefit of experience in this work; and wherever possible those who have served acceptably heretofore have been retained.

In arranging for a successor to Mr. Peck of New London County,

it was thought best to redistrict that county and add one to the number of deputies there employed. The list of deputies is here given:

Deputies for Hartford County — A. C. Sternberg, Jr., of West Hartford, Roswell A. Moore of Berlin, J. C. Eddy of Simsbury, and George F. Chapin of Thompsonville.

Deputies for New Haven County — Dennis Fenn and W. F. Platt of Milford, J. Norris Barnes of Wallingford, and Edwin A. Todd of Cheshire.

Deputies for Fairfield County — George C. Comstock of Norwalk, F. E. Blakeman of Oronoque, and R. W. Holmes of Danbury.

Deputies for Litchfield County — Ard Welton of Plymouth, and H. G. Manchester of Winsted.

Deputies for Tolland County — G. G. Tillinghast of Vernon, and Myron W. Sperry of Bolton.

Deputies for Windham County — Lucien Bass of Windham, Leonard H. Healey of North Woodstock, and Joseph B. Stetson of Brooklyn.

Deputies for New London County — James F. Brown, Jr., of North Stonington, L. P. Smith of Lebanon, C. F. Congdon of Salem, and Henry W. Morse of Jewett City.

Deputies for Middlesex County — Robert P. Hubbard of Middletown, Henry I. Nettleton of Durham Center, and Silas Payne of Cobalt.

For Special Service — A. C. Collins of Hartford, A. G. Gulley of Mansfield, and Herbert P. Smith of North Haven.

A few changes in the regulations governing the work relating to the method of marking condemned trees and to the second visit of inspection were made by the Board; otherwise they remain as heretofore.

REGULATIONS.

The hearty co-operation of fruit-growers is earnestly desired in the effort under this law to preserve the health of our orchards, and to enhance the value of their products, and deputies are instructed to use all means consistent with the faithful execution of the law, to secure such co-operation.

Trees in which any deputy is pecuniarily interested will be inspected either by the Commissioner or by some other deputy designated by him for that duty.

With this exception each deputy is expected to exercise such supervision over all peach, almond, apricot, or nectarine trees, situated within the jurisdiction assigned to him, as will carry into effect the provisions of the law relating to such trees and their fruit. All such trees should be thoroughly inspected once between July 25th

and September 1st, in each year, and if symptoms of "Yellows" are manifest, such other additional inspection should be made as is necessary for the eradication of the disease. All visits of inspection must be made before the 20th day of September in each year, except that cases of infection coming to the knowledge of any deputy which involve special danger to trees of other owners may be inspected at any time.

All trees which manifest the unhealthy twig or sprout growth characteristic of the "Yellows," and all trees which prematurely ripen their fruit with the mottled or blotched coloring peculiar to the same disease, must be condemned, and their destruction by burning ordered within ten days from date of notice. Condemned trees are to be designated by attaching to each one a card with the words "To be Destroyed" printed thereon, and as an additional means of identification, deputies are instructed to remove a small portion of bark from the trunk of each tree where the card is to be attached.

All fruit, the product of trees diseased by the "Yellows," is also subject to condemnation and destruction wherever discovered.

Deputies are required to make careful record and return of facts noted upon inspection in accordance with blanks furnished by the Commissioner. These returns must be forwarded as soon as practicable after completion of work.

In the discharge of these duties a large measure of discretion is vested in the deputy which it is expected will be carefully exercised, with the object always in mind to enforce the law effectively and to accomplish this result with the least possible annoyance to owners of trees and with economy on the part of the state.

Each one will familiarize himself with the territory assigned him and lay out his work in such manner as to make best use of his time and facilities, and this territory should be so thoroughly covered by him as to leave no dangerous source of infection unvisited.

A second visit of inspection shall be made after a suitable interval whenever in the judgment of the deputy it is necessary for the determination of doubtful cases, or to satisfy himself that the trees condemned upon the occasion of his first visit have been destroyed as ordered.

The Commissioner will inspect at his discretion.

All cases likely to involve contention or unusual difficulty should be promptly reported to the Commissioner by the deputies having them in charge.

All bills of Deputy Commissioners for services and expenses shall be submitted to the Commissioner for examination and approval before being presented to the Auditing Committee of the Board of Agriculture.

The foregoing regulations have been approved by the State

Board of Agriculture, and are promulgated for the guidance of deputies in their work, and for the information of all concerned.

J. M. HUBBARD,
Commissioner on Peach Yellows.

Middletown, Conn., July 20, 1896.

The dissemination of information concerning the Yellows has always been a prominent feature in the work of this commission, and in order to facilitate this work, and to render it more permanently effective, a concise statement of things known, and things not known, about this disease was prepared, and a sufficient number printed to enable the deputies to place a copy in the hands of every peach-grower in the state.

It is believed that nothing has been included in this statement but what can be abundantly verified, and is in fact accepted as true by all who are well informed in the premises.

WHAT IS KNOWN, AND WHAT IS NOT KNOWN, ABOUT PEACH YELLOWS.

Not, however, Everything which Might Come under Either Specification, but Only Those Things which are of Direct Practical Importance to Everyone Interested in any Manner Whatever in the Subject of Peach Culture.

To clear the ground for what is to be said on the positive side of the question, precedence in order of statement is here given to the things not known about Peach Yellows. And, first, it is not known what the real nature of the disease is. Questions directed to this point can only be answered by a statement of its progressive symptoms and its inevitable consequences. We only know that some powerful agency antagonistic to the life of the tree is at work; that the tree is helpless in its grasp, and must not only give up its own life, but if left for the disease to work its will upon, must also serve to spread contamination and death among its fellows.

Secondly, we do not know by what agency or method the contagion of Peach Yellows is, under natural conditions, spread from tree to tree. That it does so spread is as well established as any similar fact of observation can be, but whether some impalpable germ is conveyed from bloom to bloom by insect agencies, or diffused by the movement of the air, or transferred in some other way, is as yet an undiscovered secret.

We do know that the contagion can be artificially conveyed from tree to tree by the process of budding, though it appears that mere contact is not sufficient to communicate the disease, but that the diseased bud must unite and grow to the healthy stock in order to effect a transfer of the contagion. This fact harmonizes with many others which point to the conclusion that the disease exists in the circulation of the tree, and corresponds in some measure to what we would call a blood disease among animals.

Another thing we do not know about Peach Yellows is its period of incubation, or in other words the length of time a tree may carry the infection before manifesting symptoms of disease. It is fairly well settled that it may be carried over one season, and quite likely for a longer period, but just what the limit of time is, or whether there is any uniform relation of time between the communication of the infection and the outbreak of the disease, belongs in the category of unknown things. Some day we shall know these things, or a part of them, and this knowledge may light the way to a better practice, but now we must walk according to the light we have.

We turn now to a brief statement of some of the things which are known about this disease, and mention is made first of the fact that it is contagious. By this is simply meant that its nature is to spread from tree to tree. Its history proves this. From a very limited area, it has in the not lengthy period since first known spread, until now it occupies a territory in the northeastern portion of the United States bounded roughly on the south by an irregular line drawn through Maryland, Virginia, and Kentucky to the Mississippi River; on the west by the said river, and on the north and east by the limits of the peach-growing region in this direction. Outside of these limits it is not known to exist. Its contagious nature is also abundantly proven by common observation in an infected orchard, which is sure to be destroyed by it unless prompt and thorough measures against the spread of the disease are taken.

Secondly, it is incurable. This statement is made on the basis of our present knowledge. Possibly in the near or far future remedial treatment may be discovered which will restore a tree infected with the Yellows to soundness and health, but though persistently sought, no such remedy has as yet been discovered.

Thirdly may be mentioned the destructive nature of this malady. It may take several years to utterly destroy the life of a tree, but the destruction of value in both tree and fruit is immediate.

It is admitted that fruit from a vigorous tree in the first stages of the disease may find a market with consumers who are not well informed as to its character, but whatever gain may be obtained in this manner is many times overbalanced by the injury resulting from the almost certain dissatisfaction of the purchaser of such fruit, and from the maintenance in each such diseased tree of a source of infec-

tion in active operation. The declaration of our law placing both tree and fruit infected with the Yellows in the list of public nuisances, is but the recognition of a fact abundantly proven by experience.

Finally, it is known that the Yellows can be so far controlled and held in check as not seriously to interfere with success in peach culture in regions naturally adapted to it. Connecticut possesses these adaptations in liberal measure. Her soil and climate combine to give the peach grown here a flavor nowhere surpassed on earth, while the one drawback of the winter's severity is largely offset by the discovery of hardy varieties which come near to insuring annual crops.

The method of protection against the Yellows is very simple. It consists of the prompt destruction of all infected trees and fruit as soon as the symptoms of disease manifest themselves. To be effective this practice should be universal over a wide extent of territory, and this can be assured only by making it a matter of legal requirement. Several states in which peach-growing is an important interest have passed laws upon this subject, all based upon the principle that the contagious nature of this disease makes it a proper matter for legal control, and all requiring, under adequate penalties, the destruction of infected trees and fruit as the only known effectual means of suppressing this disease.

The experience of Michigan is, of all the states, the most instructive for us, as there the method of legal control has had the fairest trial, and has won its way against serious opposition to practically universal acceptance and approval. To one whose observation of its workings has been close and accurate, I am indebted for the following statement in regard to it:

" Peach-growing as an industry began in the early sixties in the southeastern county, Berrien. Within ten years it was the leading business of that section, and had spread along the lake shore into three counties north of the starting point. About 1870 the Yellows appeared in the center of the peach region, and while the importance of the trouble was recognized by many, still the majority of the growers in Berrien County refused to believe it to be a serious trouble. The far-seeing growers from the other counties asked for a law to protect them. This was only obtained by making it a local law applying to three counties along the shores of Lake Michigan and north of Berrien, the latter refusing to believe it was necessary. Under the law work at once began, and has continued to the present time, the law being changed to a general one applying to the whole state a few years later. In 1880 Berrien County had no peach orchards, they having been fully swept away by the disease. In Van Buren County, lying next to Berrien on the north, the orchards in a few of the townships were very nearly swept away before the growers fully realized that thorough work must be done. But in others this thorough cleaning out was begun at once and was kept up — not, how-

ever, without some difficulties. Many had to be educated, others would not be, and for eight years the percentage of loss of bearing trees gradually increased from two to ten. Then the change came, as sudden as it was satisfactory. In 1883 the loss again fell to about two per cent., and from that time to this has remained at about that point in all the sections where the disease once obtained a foothold and where thorough work has been done since. In newer counties still further north, where peaches are now grown largely and where the law has been fully enforced from the first, the loss has not been of importance. Berrien County, the original peach section, which was cleared of peach trees by the trouble, began again about 1885. At the present time plenty of fine orchards are growing there, but the growers as fully believe in the value of the law as in any portion of the state. That the removal of the diseased trees, which is the result of the law, accounts for the freedom of orchards from the Yellows, is plainly shown by a small section where peach-growing became very extensive, but where they were careless about the enforcement of the law, reports showing that fully one-third of the trees standing at the close of last season were affected. In no place do the growers think the Yellows can be fully exterminated, at least this has not been done, but so long as the loss from that cause is less each year than from a number of other causes, the peach-grower of Michigan does not worry over a few Yellows trees; but he knows full well that his only salvation is in the immediate removal of these few cases as soon as found."

In Connecticut the Peach Yellows law has been in operation three years,— a period too brief in which to obtain decisive results when one considers the long period in which this disease has held unchecked sway among our peach trees. Its execution encounters peculiar difficulties, owing to the large number of people whose financial investment in peach-growing is insufficient to induce them to make a study of the business and reach an understanding of the dangers which threaten it and the means of defense against them, but who at the same time keep just enough trees to perpetuate and spread the fatal contagion.

The predominant idea in the preparation of this circular has been to reach the class above mentioned. It is not for one moment to be supposed that they are indifferent or insensible to the obligations of good citizenship, and it is believed that a simple statement of the facts in the case in their proper relation to each other, if their attention can be secured to it, will bring them to a hearty support of the law, and induce them to work in harmony with the Commission in the effort to put the peach-growing industry of Connecticut alongside that of Michigan, so far as the conquest of the Yellows is concerned.

Though the results so far obtained in Connecticut are not decisive, much progress has been made towards the desired consummation.

For a detailed statement of the work, reference must be had to the annual reports of the Commission included in the reports of the Secretary of the State Board of Agriculture. There is here only space for the comprehensive statement that under an increasingly searching inspection the percentage of diseased trees has been reduced from ten to between five and six; that a large amount of information on the subject has been diffused throughout the state; that much opposition to the work has been overcome; that where the law has been defied, it has been enforced, and its validity sustained by the courts; and that each year the work of the Commission has been more effective, and has more and more commended itself to right-minded and well-informed people. Of its ultimate success there can hardly be the shadow of a doubt.

J. M. HUBBARD,
Commissioner.

In carrying out the same general plan of a "campaign of education," the following brief article, with especial reference to fruit from trees infected with the Yellows, was prepared and furnished to the press of the state, and very generally published or noticed by our papers:

COMMUNICATION FROM PEACH COMMISSIONER HUBBARD.

Mr. Editor:— Will you kindly print for the benefit of many of your readers, a brief statement concerning fruit from peach trees infected with the "Yellows."

Many times in the course of our work for its suppression have I wished that this disease was known by a less misleading name, for while a tree thus diseased will sooner or later show a yellowish cast of color, there are a number of other causes which will produce a like effect, and only a practiced eye can discriminate between them. Other and more reliable symptoms than yellow foliage are almost wholly depended upon for the detection of the disease in the orchard.

The effect of the "Yellows" upon fruit is never to communicate to it a yellow shade of color. Many of our choicest varieties of peaches are naturally yellow both within and without, and in all varieties a clear uniformly shaded natural color is always an indication of health.

If the tree is infected with the "Yellows" the color of the fruit will change to something approximating a crimson, which will show upon the surface in spots or blotches, while it will also usually be found extending in streaks through the flesh of the peach to and around the pit. Such fruit will be very apt to ripen from one to three weeks in advance of the proper season, and the process of decay

will be hastened in like proportion. Its flavor will be injuriously affected in any degree from a slight insipidity, which only an educated taste would detect, to something which makes the hapless consumer think that he doesn't love peaches, and wants no more of them.

Our Connecticut law declares such fruit to be "a public nuisance," and this declaration accords accurately with the fact.

The law also authorizes its condemnation and destruction and imposes a fine of from ten to one hundred dollars upon any dealer who knowingly "buys for the purpose of selling," or "sells or offers for sale," any such fruit.

If necessary for the protection of our markets this penalty will assuredly be invoked, but if the same result can be reached by the dissemination of information and an appeal to the good sense and highest interest of both dealer and consumer, that course will be gladly preferred and followed, and in line with this preference you are respectfully requested to give publicity to this article.

J. M. HUBBARD,
Commissioner.

Middletown, August 1, 1896.

DISTRIBUTION OF WORK.

NAME OF DEPUTY.	Number of orchards	Number of Trees.			Number Condemned.		
		Young trees three years and under.	Bearing trees four years and older.	Total.	Young trees.	Bear-ing trees.	Total.
R. A. Moore,	143	55,070	26,381	81,457	148	1,463	1,611
A. C. Sternberg, Jr.,	253	40,386	16,520	56,906	123	1,347	1,470
J. C. Eddy,	407	17,389	15,425	32,814	136	1,954	2,090
Geo. F. Chapin,	183	42,115	30,320	72,435	22	1,708	1,730
Total, Hartford Co.,	986	154,960	88,646	243,606	429	6,472	6,901
Edwin A. Todd,	232	42,214	17,451	59,665	134	728	862
W. F. Platt,	160	37,561	19,610	57,171	238	2,036	2,274
Dennis Fenn,	111	11,242	5,256	16,498	139	482	621
H. I. Nettleton,	78	2,045	6,035	8,080	.....	81	81
Total, New Haven Co.,	581	93,062	48,352	141,414	511	3,327	3,838
F. E. Blakeman,	151	6,769	3,553	10,322	74	157	231
Geo. C. Comstock,	588	35,534	13,773	49,307	81	498	579
R. W. Holmes,	264	2,436	7,252	9,688	3	569	572
Total, Fairfield Co.,	1,003	44,739	24,578	69,317	158	1,224	1,382
Ard Welton,	265	9,779	12,942	22,721	19	588	607
H. G. Manchester,	134	2,093	3,301	5,394	8	344	352
Total, Litchfield Co.,	399	11,872	16,243	28,115	27	932	959
G. G. Tillinghast,	298	12,076	8,279	20,355	9	574	583
M. W. Sperry,	221	6,925	7,570	14,495	63	470	533
Total, Tolland Co.,	519	19,001	15,849	34,850	72	1,044	1,116
L. H. Healy,	535	3,766	5,072	8,838	29	362	391
Lucien Bass,	464	8,705	8,384	17,089	170	885	1,055
J. B. Stetson,	381	5,403	4,049	9,452	7	198	205
Total, Windham Co.,	1,380	17,874	17,505	35,379	206	1,445	1,651
James F. Brown, Jr.,	303	12,719	3,966	16,685	101	364	465
H. W. Morse,	240	7,575	4,130	11,705	9	75	84
L. P. Smith,	203	9,544	11,393	20,937	76	733	809
C. F. Congdon,	398	14,979	4,824	19,803	407	472	879
Total, New London Co.,	1,144	44,817	24,313	69,130	593	1,644	2,237
R. P. Hubbard,	141	18,167	10,253	28,420	18	381	399
H. I. Nettleton,	183	4,252	9,855	14,107	10	456	466
Silas Payne,	152	6,868	3,874	10,742	44	314	358
Total, Middlesex Co.,	476	29,287	23,982	53,269	72	1,151	1,223
Total for the State,	6,488	415,612	259,468	675,080	2,068	17,239	19,307

In accordance with previous custom, I give a table showing the work done and its distribution as between counties and deputies, and in connection therewith another table giving some points of comparison in the work of the past three years.

I would gladly include the first year's work of the commission in this comparison, but am unable to do so, for the reason that the work of that year was so imperfectly organized and reported that I have not the data for a full comparison.

It may be said, however, that over ten per cent. of the trees examined that year were condemned.

The work of the deputies appointed for special service in market inspection of fruit is of such a nature that it cannot be included in this tabular exhibit. It is a work of considerable difficulty, but to neglect it would involve both home producer and consumer in hardship and injustice. Especially during the early part of the past season was there danger that our markets would be flooded with the worthless product of diseased orchards outside the State, and constant vigilance was necessary. I have every reason to believe that this work was thoroughly well done.

COMPARATIVE TABLE—THREE YEARS' WORK.

YEAR.	Number of orchards.	Trees Examined. Young trees.	Trees Examined. Bearing trees.	Trees Examined. Total.	Excess.	Trees Condemned. Young trees.	Trees Condemned. Bearing trees.	Trees Condemned. Total.	Per cent. condemned.
1894,...	5,777	199,999	222,458	422,457	Bearing trees over young trees. 22,459	1,365	22,595	23,960	5.9
1895,...	6,062	261,835	239,969	501,804	Young trees over bearing trees. 21,866	1,864	25,936	27,800	5.5
1896,...	6,488	415,612	259,468	675,080	Young trees over bearing trees. 156,144	2,068	17,239	19,307	2.8

In interpreting this last table allowance should be made, on the one hand, for the fact that more trees would probably have been condemned this year if, in some cases, the fruit had been present to give evidence as to the condition of the trees; and on the other hand, for the fact that our examinations have been increasingly severe with each succeeding year.

Perhaps these considerations may not unfairly be allowed to balance each other and leave the showing of diminished percentage of condemned trees to carry its full weight of encouragement that we are making fairly satisfactory progress in the subjugation of this pestiferous disease.

Of not less interest is the other point which this table brings out so clearly, viz.: the growth of interest and faith in peach culture in Connecticut during the period which it covers. It will be noted that the increase in number of trees examined is very largely in the class of young trees, showing that the planting of new orchards during the past two years has been on a very extensive scale. Our classification designates as "bearing trees" all that have stood in the orchard three years or more, while those that have been less than three years in orchard are designated as "young trees."

Unless trees not previously taken note of are discovered, the class of young trees can increase only by new planting, while the bearing class increases only by the yearly transfer to it of 4-year-old trees.

This transfer must amount to the sum of the losses from all causes, plus the net gains of the bearing class; and the number of new trees planted must equal the number transferred, added to the net gains of the class of young trees.

Making our calculations upon this basis, and taking account only of losses from trees condemned, we find that the number planted in 1895 somewhat exceeded 100,000, while the number thus shown to have been planted in 1896 comes very close to a round 200,000.

The bearing of these figures upon the contention of those who have maintained that the work of this commission would tend to discourage peach-growing in Connecticut is too obvious to call for comment.

I give next the usual table showing the cost of the work and its distribution. I had hoped to accomplish more work this year than last, and at less expense; but the returns show, that though the additional work has been performed, its cost has also been slightly increased from that of last year. There is no question but what the cost of the work is materially enhanced by the obstacles and hindrances thrown in its way by those who, for one reason or another, desire to defeat the object of the law. When once its authority is fully established, and the work receives intelligent co-operation, or cheerful acquiescence, a diminished expenditure on account of it will be one of the good results which will follow.

RETURN OF SERVICES AND EXPENSES OF ALL COMMISSIONERS ON PEACH YELLOWS FOR THE STATE OF CONNECTICUT, FOR THE SEASON OF 1896.

NAME.	Services.		Use of Team.		Cash paid for				Total.
	Days.	Amount.	Days.	Amount.	R. R. Fares.	Meals and Lodging.	Postage and Express.	Miscellaneous.	
R. A. Moore,	37	$185.00	37	$92.50	......	$8.15	......	$1.15	$286.80
A. C. Sternberg, Jr.,	32	160.00	31	77.50	$5.15	14.50	......	......	257.15
J. C. Eddy,	29	145.00	29	72.50	1.80	12.00	......	1.25	232.05
Geo. F. Chapin,	34½	172.50	28 3/10	70.75	3.50	31.85	......	......	278.60
Total, Hartford Co.,	132½	662.50	125 3/10	313.25	9.95	66.50	......	2.40	1,054.60
Edwin A. Todd,	27½	137.50	26	65.00	......	......	......	......	202.50
Dennis Fenn,	14½	72.50	12½	31.25	.40	4.50	......	1.40	110.05
W. F. Platt,	28 3/10	141.50	26 3/10	65.75	3.30	16.40	......	......	226.95
H. I. Nettleton,	5	25.00	5	12.50	......	1.25	......	......	38.75
Total, New Haven Co.,	75 3/10	376.50	69 3/10	174.50	3.70	22.15	......	1.40	578.25
F. E. Blakeman,	16	80.00	16	40.00	......	9.40	......	2.00	131.40
Geo. C. Comstock,	41	205 00	38	95.00	5.00	31.50	......	.75	337.25
R. W. Holmes,	23½	117.50	23½	58.75	......	13.50	......	3.21	192.96
Total, Fairfield Co.,	80½	402.50	77½	193.75	5.00	54.40	......	5.96	661.61
Ard Welton,	26	130.00	26	65.00	2.04	14.05	......	2.50	213.59
H. G. Manchester,	8	40.00	8	20.00	5.82	2.75	......	1.00	69.57
Total, Litchfield Co.,	34	170.00	34	85.00	7.86	16.80	......	3.50	283.16
G. G. Tillinghast,	18	90 00	18	45.00	......	......	......	......	135.00
M. W. Sperry,	33	165.00	33	82.50	......	19.50	......	......	267.00
Total, Tolland Co.,	51	255.00	51	127.50	......	19.50	......	......	402.00
L. H. Healy,	27 6/10	138.00	27 6/10	69.00	......	16.25	......	.75	224.00
J. B. Stetson,	20½	102.50	20½	51 25	......	32.05	......	......	185.80
Lucien Bass,	31½	157.50	31½	78.75	......	11.25	......	1.50	249.00
Total, Windham Co.,	79 6/10	398.00	79 6/10	199.00	......	59.55	......	2.25	658.80
J. F. Brown, Jr.,	45	225.00	44	110.00	......	23.75	......	1.29	360.04
H. W. Morse,	18	90.00	18	45.00	......	1.00	......	1.00	137.00
L. P. Smith,	22	110.00	22	55.00	......	10.95	......	......	175.95
C. F. Congdon,	21	105.00	21	52.50	......	8.70	......	1.94	168.14
Total, New London Co.,	106	530.00	105	262.50	......	44.40	......	4.23	841.13
R. P. Hubbard,	17	85.00	17	42.50	......	......	......	.50	128.00
H. I. Nettleton,	13	65.00	13	32.50	......	14.25	......	......	111.75
Silas Payne,	11	55.00	10	25.00	......	......	......	......	80.00
Total, Middlesex Co.,	41	205.00	40	100.00	......	14.25	......	.50	319.75
A. C. Collins,	50	250.00	..	....	53.80	40.65	......	......	344.45
A. G. Gulley,	2	10.00	1	2.50	4.91	1.00	......	......	18.41
H. P. Smith,	16½	82.50	..	....	28.90	6.10	......	......	117.50
Total, Special Service,	68½	342.50	1	2 50	87.61	47.75	......	......	480.36
J. M. Hubbard, Commis'er,	150	750.00	14	35.00	12 25	8.85	$18.60	149.15	973.84
Total for the State,	818 4/10	$4,092.00	597 1/10	$1,493.00	126.37	$353.65	$18.60	$169.39	$6,253.01

In the matter of opposition to the enforcement of the law, the storm center remains this year, as last, in New London County.

Perhaps this may be accounted for in part by the fact that only within the past two years has thorough searching work been done in this county. But, whatever the cause may be, the fact remains that a larger number of appeals came from this county than from any other, and here only have we been obliged to carry a prosecution to the higher courts.

In my last report I gave an account of the preliminary examination in the case of the State against Amasa M. Main of North Stonington for violation of the Peach Yellows law, which resulted in his being bound over for trial before the Superior Court for New London County.

He was tried at the May term of this court, was convicted, and a fine of $100 was imposed by the court.

As we had been given to expect, the case was appealed to the Supreme Court, and arguments were heard at its October term in Norwich, but the decision of the court has not as yet been made public.

In the trial of this case before the Superior Court the defense covered the ground very thoroughly, and if there had been anywhere in the law or in the practice under it a faulty point, of which advantage could be taken to defeat its enforcement, it would seem that they must have found it. The decision of the court practically declared that none such was to be found.

In the issue now before the Supreme Court the only really debatable point, as it seems to me, is whether or no the facts in regard to peach yellows are such as to justify the State in the exercise of what are known as police powers for its suppression.

That the affirmative of this proposition is generally accepted seems evident from the fact that in twelve of the United States, and also in the Provinces of Ontario and British Columbia in the Dominion of Canada, laws of similar import have been enacted, and, so far as known, the right of State or province to use its power in this manner has never been seriously questioned. But though the principle of the law be fully sustained, some of its provisions certainly do need modification. Those relating to appeals need entire reconstruction, and in other respects procedure under the law might be more clearly defined with advantage both to those who are called upon to execute it and those who are required to obey it.

This brief account of work done and results attained is submitted to the people of Connecticut for their consideration and for their approval if they find it worthy. All must agree that the object sought is one in every way desirable. The State can well afford to expend considerable sums of money, and her citizens can well afford to yield something of their individual independence at the point where it conflicts with the public welfare, in order to make such an addition to the productive resources of Connecticut and to the health and enjoyment of her people as will result from the establishment of peach-growing here upon an enduring basis.

As a means to that end a well-considered and efficiently-executed law for the suppression of the Yellows is of prime importance.

J. M. HUBBARD,
Commissioner.

REPORT OF COURT OF APPEALS FROM ORDERS OF PEACH YELLOWS DEPUTIES.

Hon. T. S. Gold, Secretary State Board of Agriculture:

Dear Sir:— The members appointed by your honorable body to constitute the Court of Appeals, met on September 25th, and visited two places where appeals had been made from the decision of Deputy L. P. Smith.

We reviewed first that of Mr. John Babcock of South Lebanon, in the same orchard from which came an appeal last year. The board found every one of the thirty-five marked trees diseased, as well as others in which "Yellows" had developed since the deputy made his examination. Nearly every case was a bad one.

At Mr. John Stanton's in Bozrahville, five condemned diseased trees were found and his appeal not sustained. An effort had been made here to clear some of the trees of the diseased limbs, but without entire success. Here, as in all cases where the appeal was not sustained, the disease was evident on the branches.

On the 26th we reviewed the appeal of Mr. Edmund Halladay of Suffield from the decision of Deputy J. C. Eddy. Here we found the remains of a fine orchard which had been given good care, except in the thorough removal of "Yellows." Some of the contested trees had been taken out before our visit and the appeal was not sustained on any of the fifty-three marked trees left, which embraced about all the orchard. This was a peculiar case, as the trees looked as green and healthy as could be desired from the road, twenty rods away, and in very marked contrast to an orchard near which had been utterly neglected for a year and looked very unhealthy, yet was nearly clear of "Yellows."

The same day we reviewed an appeal by Mr. H. C. Hayes at Buckland. This was made with the advice of Deputy G. F. Chapin, on five trees planted last spring in a lot of fifty, and along side of a fine, healthy, five-year-old orchard. The trees were evidently unhealthy, but not from "Yellows," and the appeal was sustained in that respect, but the owner was advised to remove them, as they plainly showed some trouble, the nature of which could not be determined. Young trees having somewhat the same appearance were noted at other places.

On October 9th, the board went to Baltic to review the appeal of A. A. Ray upon five trees. Here, as in the other appeals from the decision of Deputy L. P. Smith, the disease was so plainly evident there was no possible doubt of the trees having the "Yellows." Here also the board pointed out other cases which had developed since the deputy had visited the place.

The same day we went to Ashford, where an appeal had been made by E. E. Weeks on five trees, from the decision of Deputy L. Bass. The owner was not present, but his father readily promised to remove the trees after we condemned them. He said the appeal was made more to get information on the subject than to save the trees, as they were of very little value.

On October 10th, we went to the farm of Mr. W. J. Gadbois in East Lyme, where there was an appeal from the decision of Deputy C. F. Congdon. Here the board found another attempt to remove the evidence of disease from the trees, and so successful that we had to sustain the appeal in two instances, besides one other case which had been condemned by the fruit, and of which none was on the tree at the time of our visit. Twelve were left plainly diseased. The board could not but believe that an earlier visit would have proven Mr. Congdon's decision correct in all the cases.

The same day the board made two inspections in East Windsor, the first at the farm of Mr. Alfred Hayes. Here we found a block of over one hundred trees very badly neglected, and at the time of our visit, nearly destitute of foliage. The board could only fully identify eighty-five cases of "Yellows" out of ninety-eight condemned. Yet the owner readily promised to remove the whole block, as he was soon convinced that it was a source of danger to a young orchard near by. A short distance away was Mr. H. E. Beckwith, who had appealed on twelve trees. He had removed some, but on all remaining of those condemned by Mr. Chapin, "Yellows" was readily recognized.

This completed our work. One misconnection of trains, and the fact that part of the notices of appeal were not received by the board before starting on its work, obliged us to double part of our route.

In all decisions made the board was unanimous. The board feel that some means should be provided to prevent useless appeals. In

one case the avowed purpose was to make the state additional trouble and expense. Some of the others had no idea their appeal would be sustained, and they evidently knew the disease as well as deputy or Board.

Had these men known they would have to pay the expense of the appeal, if not sustained, no appeal would have been made.

Except in the case noted, we met the owners of all the trees and notified them of their decisions. At nearly all the places the deputy who condemned the trees was also with us.

Respectfully submitted,

A. G. GULLEY,
W. E. BRITTON,
G. S. BUTLER.

MORNING SESSION, December 15, 1896.

Secretary Gold. The time has arrived for opening this convention. In the absence of the president, the Governor of the State, whom we expect a little later, our vice-president, Mr. Brown, of North Stonington, will preside. I am happy to introduce Mr. Brown as the presiding officer.

Mr. Brown. We will open our exercises with music, by the orchestra of the Storrs Agricultural College. [Music].

Mr. Brown. Ladies and gentlemen: In accordance with a most appropriate custom of the State Board, we will continue our exercises with prayer, and we invite you to unite with Rev. A. F. Pierce, of the First Congregational church of this city.

PRAYER.

Almighty God, we remember Thee as the source and giver of all good. Year by year Thou hast renewed Thy blessings unto us, and every day shows forth Thy love. It is with gratitude in this annual convention that we recognize the gracious Providence that has followed us through the season just drawing to a close. For bountiful harvests and fruits of the field are more testimony of Thy love than the reward of our own diligence. Were it not for the rain and the sunshine and all the beneficent forces of nature which Thou hast ordained to do Thy will, in vain would be the work of our hands. Thou enrichest the earth and givest it to

bring forth fruits for the good of mankind. We recognize Thee, therefore, as the Giver of every good and perfect gift, and call upon our hearts and all that is within us to praise and magnify Thy name. Thou hast ordained us to live upon the earth and subdue it. May we realize that the most ennobling of all work is that which Thou didst command of men in the beginning. Grant that the time may speedily come when the true knights of labor shall be recognized in the tillers of the soil, and that Thy blessing shall ever rest upon them.

Grant graciously Thy blessing upon this association in its assembled convention. May thy blessing be upon the presiding officer and all associated with him, that the spirit of God may grant them wisdom, and so direct them that the greatest good may be brought unto each one of us. We pray for Thy blessing upon all visitors and friends here assembled. Grant that these may be quickened in their thought, and instructed in their minds, and blessed in their social relations. May they have joy as they renew the friendships of other days, and grant that these days may be those of pleasure and of profit to all who are here. Bless His Excellency the Governor of the State. Upon him and upon all of those associated with him in responsibility may the Holy Spirit descend, and may our commonwealth be blessed and the glory of God advanced.

We thank Thee that the spirit of liberty has ever sprung in the breasts of those who have roamed the forests and have breathed the free air. We thank Thee that these have ever been defenders of our nation's institutions, the institutions of liberty. Grant, we pray Thee, that these rights may ever be conserved unto us. And as we recognize all the blessings which have come to us, we would not forget our brothers who are struggling. We pray that the oppressed in other countries who are seeking for civil and religious liberty may be prospered by Thee, and may the time speedily come when they shall rejoice in this, their God-given birthright.

Now, our Father, bless us, in all the deliberations of this convention. Keep our hearts tender toward the truth. May we love Thee with full hearts, and grant that in all things we may fulfill Thy holy will. Hear us as we say together: "Our Father who art in heaven," (repeating Lord's Prayer, in which audience joined).

Mr. Brown. Ladies and Gentlemen: You are invited to listen to an address of welcome by the Hon. G. M. Rundle, Mayor of this city.

MAYOR RUNDLE'S WELCOME.

Mr. President, Ladies and Gentlemen: —

When your Secretary came here in November to arrange for this convention, we did what we could to impress him with the advantages of Danbury, eight years having elapsed since you last met here. Not until he had looked over the field and decided to hold the convention here, did he say anything to me concerning an address of welcome, which it was customary to ask of the mayors of cities visited. This, we take it, is an additional evidence of your secretary's care for your interest, and a further proof of his fitness for the position he occupies.

We are glad to welcome to Danbury the Governor of our commonwealth, the State Board of Agriculture, and the visiting delegates and friends, and in the name of the city, and in behalf of the Danbury Agricultural Society we extend to all a cordial greeting.

Danbury was occupied in 1684 by eight white people, and became a town about 1687. The first ecclesiastical society built a church here in 1696, and, during the past summer celebrated the 200th anniversary of its founding.

This town was burned by the British in 1777, and at that time had a population of about 2,500. Gen. Wooster, whose headquarters stood on South street, until a few years ago, received his death wound near Ridgefield, in giving battle to the British under Gen. Tryon, while they were on the retreat from the burning of Danbury and the supplies stored here, to their ships in Saugatuck harbor. Gen. Wooster was buried in our cemetery, and from him it takes its name.

The first building for the purpose of hat-making, and the first hat made in the United States, was made in Danbury, and this is the principal industry of our town of 20,000 people to-day, although within the limits of the town may be found some as fine farms, and as highly productive, average considered, as any in western Connecticut.

Your honorable board is familiar with the Danbury Fair, annually held here, and with the extent and character of its exhibits,

paying out about $8,000 each year in premiums, and affording entertainment during the week of its fair to over 50,000 people.

Should you desire to visit any of our factories or either of the large stock farms devoted to the raising of trotting-bred horses, or any of the other points of interest, including the city's new plant, now about completed, for sewage disposal, we should be pleased to offer you conduct to them. Remembering the injunction of your Secretary to be brief, we again bid you a hearty welcome to Danbury.

Now, ladies and gentlemen, at the request of your Secretary, I have invited in the city's nearest neighbor, the Methodist Church being almost under the same roof with the City Hall, to add a word of welcome to what the city may have presented. I have the pleasure of introducing the Rev. Dr. W. W. Bowdish, pastor of the Methodist Church.

Dr. Bowdish. Mr. Chairman, Ladies and Gentlemen, members of the State Board of Agriculture, and of the Local Society of Danbury:—I am here at a very short notice to speak a word of welcome in addition to what the Mayor has said, and at the same time possibly add a single word from my standpoint of observation that may be of some help to you in your convention. I think myself very happy that I am a resident of Danbury just at this time. I have never had the privilege of enjoying a convention of farmers, as assembled here in this place before in my ministry; and I count myself very happy that I shall have the privilege of dropping in from time to time to hear your discussions and enjoy the privilege of companionship with you.

I am something of a farmer myself. When I was quite a boy my father died, and I went to live with my brother-in-law, who was a practical farmer in Otsego county, N. Y., and during my preparatory course for seminary and college I spent my time upon the farm in companionship with one of the best farmers in Otsego county; so that I pride myself that if I were dismissed from the ministry for any cause, if I were disposed to turn aside from the ministry now, I could step out upon any one of the farms located about this state and I believe I could manage the farm, conduct all the interests of the farm, so as to secure some good results from well-planned labor. So I rejoice to-day in having the privilege of

looking into your faces and saying a few words of welcome, and giving you some idea of how I appreciate the vocation in which you are engaged.

When asked to say a few words this morning I just went to my papers and I took out some notes that I have, "The Farm, etc.," in which I have placed certain clippings during the past years. Some of them are here — for I take occasion to read in the secular press much that comes out in connection with farm life. You may possibly think that a minister has not very much to do except to study theology and get his sermons ready for the Sabbath, but I tell you it is a good thing once in a while for the minister to step aside from the study of theology and study the science of agriculture. And it always comes to me, not only as a source of instruction and blessing, but also comes to me as an inspiration. As I regard the representative men that are before me this morning, I regard them as among the most honorable of our citizens, engaged in a vocation one of the most honorable of all the hard workers in the state.

So, my friends, as I was looking over, a few days ago, the report of Secretary Morton, Secretary of Agriculture, I read with interest every line he had written concerning the reports of the condition of agriculture from all the states and territories, and I was pleased to observe especially one item that may be of possible interest to you — for it has been stated again and again that the farmers were a class of people who were to be rather commiserated because they were farmers. They were an impoverished class of people ; they were really what might be regarded as state mendicants. So when we saw a farmer out yonder tilling the soil, we were led to suppose he was one of the impoverished class, or he was one of the mendicants, so called. But do you know I saw stated in Secretary Morton's Report that, instead of that, they are really the most substantial capitalists of the country. Did you observe what Mr. Morton said in his report, that 72 per cent. of all the farms in this country are absolutely free from any possible financial embarrassment, and only about 28 per cent. have a mortgage upon them? And those farmers who are engaged in tilling the soil upon which there may be a comfortable mortgage are regarded as industrious, as honest, and therefore nothing disparaging may be said of such as have a mortgage upon the farm. I repeat it again, then, that I regard you, gentlemen, representatives of the

farmers of the state, as among the most honorable citizens of our commonwealth.

Now, having said this, let me say one thing more. I have read with very great interest the list of subjects that are to be brought before you for consideration upon this programme. There is a very wide range there ; and I said to myself, " Well, now what course shall I pursue in any practical suggestions I may have to give this morning ? " And I said, "First let me speak to these farmers concerning matters that must come to their consideration during this convention, worthy of their earnest and serious attention.

I see one item here is concerning the vacant farms, or farmlands in the state of Connecticut. I came to Danbury last October, and do you know that my heart has been saddened as I have been about in adjoining towns to see so many of these farms growing up to bushes, and the homes where there were once industrious farmers becoming demolished and passing out of sight and the farms unoccupied ; and I have said, "Is this the way the State of Connecticut is going on, and allowing these farms about here to be unoccupied?" Just go outside, and you step into the bushes and coming wilderness again of the State of Connecticut. You here are to consider this important problem. How can these farms be cultivated so as to secure results that shall be at least encouraging to any person who occupies these farms ? How is it going to be done ? Now, it seems to me that the problem has got to be solved by commencing in the very initiatory steps of education in the district schools, in your public schools, and in your colleges. Enter these district schools and you will not hear a single word in the recitations about the science of agriculture, the cultivation of the farm, or the first elements of education in this great agricultural industry. Well, now it seems to me that in these district schools in the state of Connecticut we ought to have a course of instruction that will awaken thought in the mind of the little boys who may become farmers, that they will see that there is not only a livelihood in the working of the farm, that there is dignity, there is divinity in the vocation if they will only take it up and follow it out legitimately and honestly. And so it does seem to me that commencing with the district schools in the state, and going along to the public schools of the city, then to the high schools, and then to the colleges, with a course of education followed out and taught practically that something might be done to raise up a class of young

citizens who would not go into the store and eke out a living there and be all the while an anxious care to the parents concerning their health; but that they would be robust, and be able to take up the farm work, and live to a good old age.

These matters are coming before you for consideration, and shall it be, gentlemen, members of the State Board of Agriculture, that you shall come to the convention and hear these discussions, and resolve you will do so and so, and yet not make that thing practical? It is one thing to have a convention to resolve that the farm shall be occupied, and it is another thing to make that resolution practical, and prepare these young farmers to take these lands and till them to profit.

Oh, but you say, "Can these farms be redeemed?" I think they can. The other day, coming down from Ridgefield, just the other side of the brook, on the road that leads from Star Plain to the road to the city, I looked out of the carriage and saw a member of my church digging away with a grub-hook, and he seemed to be greatly interested in his work; his face was flushed, and he really seemed animated in the work he was doing. I said to the driver, "Stop a minute"; so he stopped, and I looked out and said, "How are you this morning?" And he said to his hired man, "Who is that?" The hired man discovered who I was, and gave my name, and then he said to me, in reply to my question, "I am going out of the sumach business and going into sowing a better crop." What was this man doing? He was digging out quite a wilderness of sumach, and there was a great pile of roots, and a pile of brush, and he was hard at work. Then I said to him, "When you get this plowed and fixed for a crop I want to come out and see how it looks, for I think that it is a good piece of land; I think when it is redeemed it will produce one of the best crops of rye ever seen in the state." So in a few weeks I went out there and said, "I want to see that piece of land you put into such a nice state of cultivation, because I know you have done your work well." We went out there; and you ought to see that land; especially the place that was occupied by a wilderness of sumachs. You ought to see the promise of the crop that is there! And now I am watching with the intensest interest to see what shall be the result of that well-tilled land and the well-sowed crop. We are going to have an abundant harvest. That is an example.

So I trust there will come such inspiration into the discussion

of the question, what shall we do concerning these farms unoccupied? that before another year we shall find that some work has been done — that some of these farms have been taken up.

I have read over carefully this book I hold in my hand, your report of 1872. Also the report of 1888. I said to myself as I read those two books, "There is the concentrated thought of the representative farm-life of the state of Connecticut." If you read that report of 1872, and then this report of 1888, and if you don't see progress, if you do not see that there has been practical application of the suggestions and information given you here in your conventions in this town, then I am very greatly mistaken.

Said a good farmer to me over there in my yard just before the Danbury Fair — I was urging him to go to the Danbury Fair, for "it is a good thing," I said. "I know it is." "I have heard about it ever since I was born, almost, but I am going over this year to see how it is, to see if it bears out its well-earned reputation." "Well," said he, "if I thought I could go to the Danbury Fair and find out how these onions I have raised this year could be rid of those dark spots, on those white onions, I would go; that would pay me." I said, "My friend, you go to the Danbury Fair, and I will venture the assertion that you will find some onions there that have not got those dark spots on; and if you find the onions are exhibited by John Smith, go for him and ask him how he did it, and John Smith will tell you all about it." So when I went over to the Danbury Fair the first day I went to the onion table. I said, "Let's see if we cannot find some onions here that have not the dark spot on" — and I had one of his in my pocket. I took it out of my pocket and compared it. Do you know there were no dark spots on those onions, and I found out the man's name that raised them, and I said, "Now go for that man and he will tell you how he did it, and you make your application on the next crop of onions you raise and you will have a good crop of onions, and they won't have dark spots."

These talks, this brotherly companionship, these familiar conversations you are to have with each other, gentlemen, are to be, not only sources of information to you, but they are to be sources of inspiration to you in the farm life of to-morrow, of next week, and of next year.

I was greatly interested in the Danbury Fair last season; I visited it every day but one, and I went there as a student, desirous of

knowing more of the science of agriculture; I went to every stand; I saw every sample of grain; I saw the pigeons and the chickens; and I did go in to see the dogs, but they made so much noise I could not see them much, and I turned around and came back. Then I went down to see the cattle, and I went to see the sheep; and I went along and asked the farmer who was there with these cattle and with these sheep, "How did you produce such a fine sample, such a fine stock of cows as you have here, and oxen, and sheep, as you have here?" "Oh," said he, "It requires great care. You must put a good deal of thought upon it, and give it constant care; but you can have it every time," they said to me. So I went around from point to point, and I said to myself, "This Danbury Fair is one of the grandest institutions of this state, from an agricultural standpoint." I tell you that these fairs should be made more of than they have been in the past in your state; and I would have my good brother Atwater stationed there during the progress of the fair, and I would have him conduct a series of lectures in the presence of the young people — boys and girls; I would have a school-day there; I would have a college-day there, as well as a state-day; and I would have some of these professors from some of these agricultural colleges or schools, in your own state or the other states, I would have them come here and give a course of lectures upon the subjects that are there represented by the different samples of grains and grasses, and stock of cattle, sheep, and horses, I would do that. Then I would have a state-day; I would have the Governor of the state, whoever he might be, with his staff, come there, and he should not only come on dress parade to show himself, but I would have him stand in a comfortable place, with a sounding-board, so that vast area before that grand-stand might be filled with the interested multitudes, to hear an address from the Governor of the state, and from the Secretary of Agriculture of the United States — some address that would be an inspiration to the great agricultural interests of the state. I would do that. Why, among the earliest impressions of a speech I remember was that one delivered by William H. Seward, than whom a more honorable statesman never lived, afterwards Secretary of War under Lincoln. He stood in that great fair of Otsego County, N. Y., and delivered the magnificent address in the presence of assembled thousands. I remember many things he said.

So, gentlemen, while I congratulate you this morning with all

my heart, I hope your considerations here will be such as to help solve some of these problems that face us in the state, that we shall make our informatlon practical upon the soil of which we are possessors.

Thanking you for your attention, I bid you good morning. [Applause].

Mr. Brown. Ladies and Gentlemen: While we are digesting some of the practical thoughts which Dr. Bowdish has given us, and which he has very carefully sugar-coated, so that we could enjoy them, especially that grubbing up of the sumach patch, which is much pleasanter to contemplate in the way he has referred to it than it would be to engage in the action ourselves — I say while we are digesting these things, we will listen to some music by the orchestra.

[Music].

Secretary Gold. I will take this opportunity to give some notices. The Question Box is here upon the table, to receive questions upon any subject appertaining to rural life; these will be brought up for discussion and answer, as far as possible, during the course of the convention. We shall have some of these professors and others connected with our Experiment Stations and Agricultural Colleges, etc., who will undertake to answer almost anything that you choose to put into the box. That is what we calculate to have them do for you. And if the professors cannot answer we trust there are practical farmers here in the audience who can. They always have a reason for everything that happens on their premises.

Owing to the time of the running of the trains, the Governor had announced his inability to be here early; but he has fulfilled his promise to be here at this time, and the lecture from Mr. Hubbard will give way for the address of the Governor, so that Mr. Hubbard's lecture will come the first thing in the afternoon.

Mr. Brown. I have the pleasure, ladies and gentlemen, of presenting to you His Excellency, Governor Coffin, who will now address you. [Applause].

ADDRESS BY GOVERNOR COFFIN.

I value punctuality very highly, as I believe all the agriculturists of the state do,— but I could not walk, and I could not drive to get here earlier than this, so I was forced to take a train — and there was no train by which I could arrive in better season. I regret that I am late; but I hope that my lateness has not interfered materially with your proceedings.

Mr. Chairman, Members of the Connecticut Board of Agriculture, and Ladies and Gentlemen of the Convention:

It affords me much pleasure to be present for the second time at an annual convention of the farmers of our state. Another year of experience and observation has served to increase rather than diminish my estimate of the importance of the interests you represent and appreciation of the intelligence and assiduity with which your service to those interests is rendered.

The year has been one of hardship to the great majority of our people who are engaged in other pursuits — and you have not entirely escaped a share of their misfortunes.

The population of the state is steadily increasing, being now probably not less then 825,000, showing an increase of more than 75,000 during the last six years. This obviously has improved the local demand for the products of the farm. In this connection it is interesting to observe that the area of improved farm land has very largely decreased during recent years, thus greatly reducing the number of acres from which the demand is supplied.

Roughly speaking, there are about 3,100,000 acres of land in the state and 93,000 acres of water. I have found a statement in the report of the U. S. Commissioner of Agriculture for 1867, evidently based in part upon the census of 1860, in which about 487,000 acres of land in Connecticut were classified as "wild or waste." Adding this amount to the census figures of 2,503,000 acres for "improved" and "unimproved" land in 1860, and we have a total of 2,990,000 acres. Taking this total as the basis, and making the calculation in the same manner, we get the figures for "wild or waste" land, of 606,000 acres in 1850, and 737,000 acres in 1890, showing an increase of 131,000 acres in the forty years.

Much has been said from time to time about abandoned

farms, and many have doubted that the matter has assumed important proportions.

In view of these facts, however, it certainly seems that the subject is worthy of attention, and I am glad to see by the program that we are to have a paper by Mr. Hinman on this subject this afternoon.

It is a cheering fact that the value of our farms has largely increased in spite of the large decrease in area of improved land. From a value of $82,000,000 in 1850, the figure had risen to $108,000,000 in 1890 — an increase of $26,000,000. These figures included implements and machinery, and live stock on hand, in both cases. Deducting for these items, the increase in farm values was $23,000,000. But it should be added that, as compared with the values in 1870 and 1880, the figures of 1890 show a heavy decrease.

Another interesting fact is that the number of farms increased from 22,445 in 1850, to 30,598 in 1880, and then decreased to 26,350 in 1890. Prices of the leading farm products have, as a rule, during recent years, averaged much lower than at earlier periods. Various opinions have been held as to the cause. Some millions of our countrymen have been persuaded (and I make this allusion to them without desiring to give any political appearance to what I say) that the relation of a single kind of money to the entire money circulation of the country has a vitally important bearing upon this subject. But let us see if we cannot briefly account for it in another and more or less familiar way. The population of the United States in 1850 was about twenty-three millions, and we had 113 million acres of improved farm land.

In 1890, the population had increased 170 per cent., while the increase of improved farm lands was 215 per cent. The reduction in cost of transportation by rail and water is a prime factor in the control of our eastern markets. Before the Erie Canal was built it cost $100 to transport a ton of freight from Buffalo to Albany, a distance of 300 miles, and the time required was twenty days. This would make the rate on wheat about $3 per bushel, a prohibitive figure. Upon the opening of the Canal the rate fell to $10 per ton, or twenty-nine cents per bushel from Buffalo to New York — say 450 miles. Now wheat and other grains are carried at times for as low a rate as two mills per ton per mile, which gives a cost of only fifteen cents per bushel for a distance of 2,500 miles! Ocean rates are also exceedingly low. The productiveness and ease of

tillage of a large portion of the new land added to the improved farms of the country, combined with the low cost of transportation places the producer within reach practically of all the markets of the world. But the situation as to foreign markets for our produce has changed to our disadvantage. The producers of other countries have now similar advantages as to production and transportation and are raising large crops.

The resulting competition for a market forces prices down, and it is only when there is extensive failure or reduction of crops that remunerative prices can be obtained for the leading food products of the farm.

It would be interesting to pursue this discussion more in detail, but I will only tarry to suggest the obvious conclusion that the relation of supply to demand is an entirely adequate cause for the fall in prices. Increased demand or decreased supply, or both, may bring about an improved condition of things in the future. It is easy to believe that by diversification of the agricultural industries of our state and the application of correct scientific principles of cultivation, our intelligent farmers are able to secure on the whole greater independence and more of many of the comforts of life than the larger part of their fellow citizens engaged in other occupations.

Your attention has frequently been given to the subject of sheep husbandry and it seems to me singular that more has not been done in this direction. I observed recently in some agricultural paper an exceedingly interesting and practical article on this subject by our secretary, Mr. Gold. But hindrances of some sort have discouraged this branch of farming, and sheep are steadily disappearing. In 1850 there were 174,000 in the state, and in 1890 only 37,600. Some charge the dog with being the chief enemy of the sheep. It was recently said that we have now 50,000 dogs (a low estimate, probably) and 30,000 sheep, and that some people appear to think that the proportion of sheep is too large. But dogs killed only 1,502 out of our nearly 40,000 in 1889, according to the census of 1890, while about 1,800 were killed by the weather. Mr. Lyman of Middlefield, whose flock of sheep numbers now about 3,000, tells me that he has very little trouble with dogs, although dogs abound in that section. He finds sheep bells, in considerable number, a sure protection for his sheep. During ten years when he had from 500 to 1,000 sheep, his total loss by dogs was fifteen head.

The course of things with reference to cows has been different from the experience with sheep. From 85,000 in 1850 the number in this state increased to about 128,000 in 1890.

The census figures for the milk product covers only the period from 1870, at which date the annual product for Connecticut reached about six and one-quarter million gallons. In 1880 it was twelve and one-quarter million gallons, an increase of nearly 100 per cent., and in 1890 had increased to nearly fifty-four and one-half million gallons per annum, or about 350 per cent. These eloquent figures indicate the enormous growth of our dairy interests and their consequent importance to the farmers of our state. In this connection some reference to tuberculosis may be appropriate. The efforts to check and stamp out the disease in the way provided by law were continued and extended during the year ending September 30th.

The commissioners appointed by the board examined 5,126 head of cattle and killed 787. The average sum paid to owners was $24.76 per head, amounting to over $19,000, and the total expenditure by the state was $28,640.61. The difficulties in the way of a satisfactory prosecution of the work under existing law were mentioned somewhat at length in my remarks to you at your convention last year, and the situation in that respect remains, of course, unchanged.

Some modification of the law will doubtless be made by the incoming General Assembly, and I am sure that you will, without urging, give your intelligent consideration to this exceedingly important subject. Opinions still differ widely as to the danger to the people involved in the use of the milk of affected cows. The tendency of accumulated evidence seems to me to favor the affirmative rather than the negative side of this question. On the point of the cause of the disease there is also a diversity of sentiment. The extent to which some of the best herds in the state have been found to be affected during the past year, in spite of the best of care as to food, cleanliness, and fresh air, seems to me fatal to the view frequently urged, that the origin of the disease is to be found in the manner in which stock is kept. The most desirable points to be gained are first to discover some method to determine the extent to which the disease exists in each case and the stage of progress of the disease at which the milk and meat become unhealthy. Careful scientific investigations are now in progress in the hope that these points may be successfully covered.

One eminent investigator tells me that milk from infected cows heated to a temperature of only 165 degrees F. and kept at that point fifteen minutes will thus be rendered entirely safe for use.

Another exceedingly important question is whether at any stage of its progress the disease can be arrested or cured. With a view to a thorough effort to determine this point, several very fine animals indicated by the tuberculin test to be diseased are to be made the subjects of careful scientific investigation at Storrs College.

The information gathered by the commissioners during the year will be presented by them in detail later on, and will be exceedingly interesting and important to us all. The commissioners have applied themselves to their perplexing and difficult task with earnestness and industry and have appeared sincerely solicitous to discharge fairly the duties imposed upon them. It is interesting to note that the number of working oxen in the state changed from 47,000 in 1850 to 21,000 in 1890, while the number of horses went from 27,000 to 44,000 during the same period. In 1850 there were 174,000 swine in the state and in 1890 the number was just under 38,000. In 1850 we raised nearly two million bushels of Indian corn and in 1890 a little less than one and one-half millions. Of wheat the figures were 42,000 and 7,500 bushels. Of oats one and one-quarter million bushels and 600,000. Of buckwheat 230,000 and 46,000 bushels. Barley 19,000 and 5,700 bushels. Rye went from 600,000 to 215,000. Hay from 516,000 to 613,000 tons. Garden stuff and small fruits are coming into prominence, their value being stated for 1890 at $371,207. Tobacco went from about one and one-quarter million pounds to nearly nine million pounds. Thus the tobacco crop has become a very important one in the financial sense. I have been deeply interested in all these figures and would be much pleased if time served to comment upon them and hear them discussed.

They may be well known to you, but I have not seen them grouped in this way and am confident that they are not familiar to a large portion of the people of the state. Their interest and importance must be my excuse for presenting them at this time. While in some respects they seem to give unfavorable indications, in others they are significantly favorable, and on the whole may be largely the result of a readjustment of relations and interests.

The admirable work of the agricultural experiment stations at New Haven and Storrs College has already proved exceedingly helpful to thoughtful farmers, who have availed themselves of its results, and it is, I believe, to be of constantly increasing value during coming years.

In view of the fact that you are all interested in the financial affairs of the state, a few words on this subject may not be out of place just at this time. The report of the State Treasurer recently made shows a considerable excess of expenditures over receipts for several years.

The situation calls for careful investigation and action.

Expenditures are very largely determined by law and therefore cannot be very materially affected by action of the Governor or other state officers. As to matters in regard to which discretionary authority is lodged with the Governor, it has been my constant aim to act as conservatively as possible without inflicting needless injury upon interests involved.

It is worthy of note that the ordinary receipts during the last year were larger than for any other year, with one exception, for the last ten years. The amount for last year was $2,117,819.27, and for 1890 $2,261,202.84, but in the latter year the town tax, discontinued the following year, amounted to $354,557.65, leaving the amount received from the same sources from which income was received last year $1,906,645.19. It is true that the receipts for 1893, $2,290,952.26, were a little larger than those of last year, but of this amount $261,981.90 was received from the United States in repayment of the direct tax paid by the state during the war. I state these facts to indicate that the change in financial condition is not due to any diminution of receipts from ordinary sources. With the increase of population there has been a constant increase in the cost of caring for the poor and unfortunate, the punishment of criminals, the provision for educational institutions, and for judicial machinery for the enforcement of the laws.

Then new items of expenditure appear in connection with the work of checking the spread of disease among domestic animals and the improvement of the public highways.

The question whether it be practicable and desirable to largely reduce the expenditures in any or many of these directions, or to so rearrange the plans for securing increased income, or both, demands, and will doubtless receive, early and thorough consideration.

There are other matters in connection with our state affairs which it would be profitable to discuss, but the lateness of the hour admonishes me not to detain you from the further and more interesting exercises of the day. As this is the last time I shall be with you, in my present capacity, I cannot close without an expression of my official and personal gratification at the spirit of kindly regard manifested by you toward me and your generous appreciation of such efforts as I have been able to make to serve the interests of the people of the state. [Applause.]

Gov. Coffin. Col. Brown insists that I shall preside, and if he and Mr. Gold will tell me what to do and what to say I will be happy to occupy the chair.

[Music.]

Gov. Coffin. Any subject presented during the morning is before you now for discussion.

(There appearing to be no inclination for discussion, the Secretary announced that the Governor would hold a brief reception at the conclusion of the morning session, and at 11:45 a recess was taken until 2 P. M.)

AFTERNOON SESSION.

December 15, 1896.

[Music.]

Gov. Coffin. Ladies and Gentlemen: It affords me special pleasure to present as the first speaker of the afternoon my friend and fellow-townsman, Hon. J. M. Hubbard, who will speak to us on the text of "Hard Times."

HARD TIMES.

By J. M. Hubbard, Middletown.

There is somewhere on record a maxim which approves of the eating of the bitter before the sweet, in order that the sweet may taste the sweeter. It may have been in accordance with the principle thus laid down, that Mr. Gold has placed a consideration of the bitter subject of hard times at the opening of the feast which he has prepared for you on this occasion.

The sweet morsels will come later and, according to the excellent and time-honored rule, the very sweetest will be kept till the last.

Even bitter things may be wholesome. In articles of food the bitter flavor has its place and use; while in medicine, as we all know to our sorrow, it comes to the front in a very positive and pervading fashion — so much so, indeed, that its absence from any remedy almost impeaches its value. And in the graver concerns of life, in character building and the development of moral strength, bitter experiences are almost or quite indispensable.

Pain teaches us how to endure; sorrow purifies and refines; through loss we come to inherit rich possessions; and even hard times may have for us a recompense worth all its cost. If so, let us seek for it.

The deficiencies of this discourse will be many and great, but whatever its lack may be, it is bound to possess the great merit of timeliness.

There could hardly be imagined a more fit and favorable time to study the subject of hard times than the present, for it has recently come under the observation of everyone, and it would seem that nearly everyone had shared in its experience.

Taken in all its bearings it is much too great a theme to attempt to handle in any thorough manner in the brief space of time at my command, and with the limited ability I am able to bring to the task; and, realizing this fact, I tried to think of some subtitle which might be used to indicate the limitations within which I would try to keep myself.

But I somehow could not think of anything which promised to perform that service for me, and so let the title stand in all its comprehensiveness, reserving to myself the right to go anywhere in the broad field of discussion pertinent to the theme, and to leave off wherever and whenever I should choose.

Of the subtitles which came into my mind, "Cause and Cure," was the one which pressed itself upon me most persistently, but I rejected it, because it seemed to cover such an immense territory that I did not dare announce that I was prepared to occupy it. I shall, of course, have something to say of the causes of hard times, and I may offer suggestions of a remedial nature, but I do not come with any new discovery in regard to the subject which, with a power like that

of the Roentgen Rays, may enable us to see through matter opaque to ordinary vision, and thus lay bare the whole chain of causation leading up to it. Neither do I come with any pill or powder, which, taken according to directions, will cause the trouble to vanish in a night. And, of course, I am destitute of those wonderfully convincing arguments in favor of whatever I may offer as a remedy, which consist of photographs of the patient "before taking" and "after taking," with which the advertising columns of our newspapers continue to be made attractive to us.

It would be a wonderfully good thing, wouldn't it now, if I could come to you and say with truth, "I have discovered the cause of hard times." It is just this and nothing else or more. And now if you will adopt this simple remedy, hard times will trouble you no more. If I could say this truthfully, you could afford to lavish upon me a fortune equal to what Helmbold got from his "Buchu," or Green from his "August Flower," or even Lydia Pinkham from her famous, or *in*famous, "Compound." But no such thing as this can come to pass.

Hard times, if it be a diseased condition of the body politic, is one which will not yield to any dose of such a nature. It will yield only to such a change in the life habit of the organism infected by it as will neutralize the malign working of the forces which bring it about.

One of the lessons we all very much need to learn is to avoid quack remedies for the ills which afflict us. This lesson applies to ills of the body, ills of the mind and soul, ills of the social and political organism, and, indeed, in the broad sweep of its application, nothing that needs a remedy is exempt. We cannot find the true until we reject the false.

But some people tell us that hard times is not a disease, but, rather, a natural and healthful manifestation of the forces which impel and control business activity. It may be bitter, they say, but it is a needed bitter and one which works for health and righteousness.

It is, as they point out, rhythmic and periodic in its appearance and apparently in harmony with the law which governs the progress of the race and decrees that it shall not be a steady onward movement, but an alternative of rapid advances and long halts, which are sometimes accompanied by a retreating movement of considerable magnitude.

It is also paralleled and illustrated by many of the move-

ments of inanimate nature; by the ebb and flow of the tide, by the rush and recession of the waves, by the succession of the seasons, and the changing phases of the weather. Beyond doubt there is truth in this view of the subject, but it is also true that excessive action of many of the normal functions of the body constitutes disease and involves danger, and when the ordinary and beneficent movement of the tide swells to double and treble size and force, it carries disaster and ruin in its path.

The instance of hard times which has been under our observation and has entered so largely into our experience during the past few years, if, indeed, it be a case of ebb and flow of the forces of business activity, deserves to be classed as a tidal wave of disaster.

Like the "high tide on the coast of Lincolnshire," celebrated by one of England's sweetest poets:

> "That flow strewed wrecks about the grass,
> That ebb swept out the flocks to sea,
> A fatal ebb and flow, alas!
> To many more than mine and me."

So to very many this tidal wave of hard times has been a harmful and even fatal "ebb and flow."

Fortunes supposed to be reasonably secure have slipped from their owner's grasp in spite of most strenuous efforts to retain them.

Values believed to be permanent have vanished like the morning dew.

Want has succeeded to comfort in myriads of homes, and sharp limitations have been enforced upon uncounted thousands, who believed that they had won their financial freedom and it only remained for them to enjoy it. There have been cases— thank God, not many, in which strong men have chosen death rather than life, because life held to their lips the bitter cup of the consequences of hard times. Other men, and a great many of them, lived on, accepting the burden imposed upon them, surrendering the hopes of ease and comfort which they had so fondly cherished, reconciling themselves as best they might to changed and narrowed conditions, and seeking to make the most and best possible out of what remained. The men who did this certainly did not lose their self-respect or the respect of their fellowmen, however great their losses in other possessions.

Then it should be stated that notwithstanding the severity and universality of this visitation of hard times, there are many people to whom it is matter of observation only. They have no share in its experiences. It may come near them on this side or on that, but they are so conditioned that it does not touch them.

What is to be said in regard to them? Are they to be congratulated or commiserated?

I hardly know. Two things seem to me to be tolerably clear, one of which is of primary interest to the class mentioned, and the other to the rest of the community. The first is, that it may be, yes, I will say it must be, a misfortune to anyone to have no share in an experience so profound as this, which comes to the group of people of which he is a member.

Prosperity is a good thing, but prosperity, when one's comrades are suffering from adversity, especially prosperity which, as is sometimes the case, is derived from the adversity of others, must contain an element which a man of sensitive nature would wish could be eliminated from it. My other observation is that hard times brings a definite aggregate of hardship to be endured by somebody. If all share it, it is easier for each individual. If some escape it, it is all the harder for the rest. But what ought to be done by or to this group of fortunate or unfortunate people, it is not given me to say. The word of the Lord to them must come by some other prophet.

How came this wave to strike us with such destructive force? The usual portents of such trouble were not present.

We had long been free from war and war's destruction. Shortage of crops here and there had not affected the general abundance of food products. In spite of occasional local outbreaks of disease, the general health of our people had been good. It was a time of health, plenty, and peace. And right out of this condition of things came disaster, trouble, suffering. Now, it would be a conclusion contrary to sound reason to say that the suffering and trouble and disaster were in consequence of the health and plenty and peace which we, as a people, have enjoyed, and yet it is entirely obvious that the favorable conditions enumerated have not prevented the disasters from which we have suffered and are still suffering. Something more than these are necessary if we are to be secure from hard times.

Suppose that at any time within the past three years, some-

one had started out to learn by inquiry what was the matter with the business situation, and encountering first the manufacturer, had put to him the question, "What is the trouble with the times?" he would have received in substance this answer, "My line of business is overdone. I cannot dispose of my products. The market will not take them, and I have been obliged to cease or greatly curtail operations, and so to throw a lot of people out of work." About all manufacturers, except bicycle-makers, would have united in this statement, and by next year they may join in and make the refrain unanimous.

Leaving the manufacturers and going to the farmer with this inquiry our investigating friend would receive in reply the same statement with only this difference, that the farmer cannot shut down and stop work, unless he quits business altogether and turns to some other occupation to increase the pressure of competition there.

The tradesman would answer much in the same strain, and the result of our inquirer's search for information would be to leave him under the strong impression that our trouble was simply a case of plethora — that we were gorged with good things, and needed only to sit down and wait until our accumulated surplus was consumed, and then resume our wonted activity. But the man who would sit down and wait must be in possession of enough of the surplus production to sustain him during the waiting period, and it very soon comes to our notice that a great many people haven't got in their possession the means to enable them to wait. Should our investigating friend pursue his search for information among this class of people he might early make the observation that the surplus which so troubled the manufacturer and farmer had suddenly ceased to be conspicuous.

However much markets and warehouses may be gorged with the products of field and factory, there is not and has not been any plethora in the homes of the great mass of our people. Wheat may have been wasted in the granaries of the West, and corn been burned to keep the settlers on the frontier warm, and clothing fabrics lain long upon the shelves of the dealer, waiting for the slow-coming purchaser, but at the same time men, women, and children were pinched with hunger and shivering from cold. Production may have outrun the demands of the market, but it does not certainly appear that it has exceeded by the measure of a grain of wheat or a yard

of cloth the reasonable needs of our people. Are we not justified in the conclusion — nay, are we not forced to it, that the foundation, away down deep, of this, our trouble, is to be found in a faulty and inadequate distribution of products, producing dislocation and lack of equilibrium between production and consumption.

Now, I shouldn't wonder if some of you, and, perhaps, all of you, were beginning to think and getting ready to say that I am getting beyond my depth, and had better face about and make for the shallows or the shore.

You, who think this, may be correct in your judgment, but I cannot accept your advice. I must push forward even if I get where I cannot touch bottom and have to swim for it.

I am a fruit-grower. What I need to make my business prosperous, and drive hard times away from my door, is that all fruit-lovers shall be able to gratify to the full their desires for this delicious, healthful, nourishing product.

My next neighbor is a dairyman. He needs that people shall be able to buy freely and largely of his valuable product. Our interests lie exactly in the line of the interests of those with whom we do business. We do not wish to get something for nothing. On the contrary, we wish to give a full equivalent for what we get, but we do wish to give largely, and receive largely in return.

So of all parties engaged in legitimate production, and so also, I take it, of those who give service instead of product in exchange for what they receive. All desire to give largely, and they wish to receive largely in return.

Again, I recur to the word equilibrium. It is a word of tremendous import. Upon that condition of things for which it stands depends the orderly movement, if not the very existence, of the universe of which we are a part.

Centripetal and centrifugal forces, positive and negative forms of electricity, pressure and resistance, heat and cold, balance each other, and in their equilibrium the functions of existence go on successfully. Loss of equilibrium is the cause of catastrophes in the natural world, and it can hardly be otherwise in social and industrial spheres.

A problem which for ages has pressed upon thoughtful people is this, "How shall the earth be made to supply sustenance for its constantly increasing population?" Is it presumptuous to say that this problem has been solved, and that within the lifetime of men not yet old? I question if even well-

informed people thoroughly realize the tremendous advance in the science and art of production made within the past half-century. New principles have been discovered and applied, new forces pressed into service, and new mechanical devices employed which make these forces wonderfully effective in production.

But when it comes to the distribution of this multiplied production we have only the old method, the old principles, the old agencies, and it is no wonder they have broken down under the strain. Perhaps someone will here point me to the new agencies of transportation as proof that my last statement is an error. I gladly admit and recognize the efficiency of these new agencies and their adequacy for the work for which they are designed, but from their very nature they stop short of what is needed. Of what avail is it to the workingman in New York that a barrel of flour is very swiftly and cheaply brought from western wheat fields and mills to the corner store nearest his home, when the cash equivalent for that barrel is resting in some other man's pocket? How much does it help the western producer that this man wants his product, and that the railroad is able and ready to carry it to him if he have not the means to buy it when it gets there?

The function of distribution may be helped, but it is a long way from being completed when you have brought the useful product near to him who needs it. If he have not the means to get it, the barrier between him and the thing he desires and ought to have, is just about as impassable as if it were reinforced by a thousand miles of space.

Don't you see — cannot anyone see that a thorough effective distribution of the products of industry, such a distribution as will relieve the glut of the market, and bring about a free, healthful, throbbing circulation in business channels, can come only through a prior distribution of the money which represents those products and will command them in the market? But, you say, this is downright rank socialism. Well, what of it? We are all of us socialists in fact, only we are apt to be a little scared at the name. Civilization is socialism; it cares for its weaker members. Christianity is socialism, its maxims being, "Look not every man on his own things, but alos on the things of others." No one of us but what admits the force of these principles. No one claims the right to live wholly to himself, and absolutely without consideration for others. The difference between us is not a difference of basic

principle, but a difference in judgment as to the extent to which we shall carry our principles into effect. In this connection I am reminded of a story attributed, as are many other good stories, to Abraham Lincoln. It is said that someone, noticing his conspicuous length of limb, and thinking to make it the point of a joke upon him, asked him this question, "Mr. Lincoln, how long do you think a man's legs ought to be?" "Just long enough to reach the ground," was Mr. Lincoln's reply, and in practical matters we can find no better rule for the use of a principle in which we believe than to continue such use until it produces the desired results. If we stop short of that, our principles are of as little use to us as would be a pair of legs dangling a foot from the ground.

I beg to assure you that I am not arguing this matter on any sentimental basis, nor am I simply trying to carry out some theory which has got possession of me. I am presenting simply the need of the great body of producers, of whom I am one. We are producing largely of good things. There are plenty of people who want our products. The agencies of transportation are ample to handle them and place them wherever they may be wanted. But the people who ought to have them haven't the money to pay for them. There is plenty of money in the country, but it isn't performing its proper function. Its circulation becomes clogged, trade slacks, workmen are thrown out of employment, and cease to buy except for sternest necessities; our products cannot be disposed of at remunerative prices, and hard times are upon us. In this condition shall we sit down and say, "Nothing can be done to cure this evil? Thus it ever has been, thus it is, and thus it must continue to be?" Such an attitude of thought is unworthy of free, progressive, Christian people.

We have solved, as I have already remarked, the problem of ample production, and it was one which hung like a dark and threatening cloud over many generations, and now shall we give up and say that the far less difficult task of restoring the disturbed equilibrium between production and consumption is utterly beyond us? Not unless we want to write ourselves down as unworthy of God's good gifts, and incompetent for the tasks He calls us to perform.

Well, if the cause of hard times, and I mean now excessive hard times, that which pinches and tortures its victims, and wrecks enterprises and leaves them stranded on barren shores, if I say the cause of this sorry experience be an imperfect and

wholly inadequate distribution of the products of industry, what is the true and effective remedy? It seems clear that the cure must come from something other and more than individual action.

It is well to practice the homely virtues of prudence in business, and economy in living. These have a tendency to place the individual who practices them outside the sweep of the tidal wave when it comes. They have this tendency, I say, but they are not certain to do even this. And the reason is that no man's business stands alone. In civilized life the work of each must be combined with that of many others before it becomes effective, and if disaster touches the connection at any point, the thrill of it is felt by all who are joined in that connection. So any remedy or preventive, to be effectual, must be of a general nature. It must be the act not of one or many single individuals, but of the organized community.

Now, I do not see but what I shall be compelled to talk politics. There is no help for it.

Luckily, it is December and not October, and in December of the year of a presidential election one may freely and without offense say things which it would not do at all to say from this platform in October.

I said awhile ago that one very important thing to learn in administering to the needs of a diseased organism is to avoid quack remedies. It is much more important than it is easy. Such remedies will be vociferously pressed upon our attention by those who have other interests in view than the restoration of the patient to health.

Sometimes these interests are very dark and sinister, and, in such cases the pressure in their behalf is apt to become more severe, the recommendations more emphatic, the promises more alluring. Plausible theories will be constructed to support these promises, and specious arguments advanced in behalf of the recommendations, the fallacy of which it is not always easy at once to point out. And every effort will be made to prevent that deliberate consideration of these suggestions which might enable one to discover their fallacy. We will be told that delays are dangerous, that our case is going from bad to worse, and will soon be beyond hope of cure.

One needs to brace himself against this pressure, to assert his right to think for himself, to insist upon time and opportunity to think, and to be willing to perform the work of

thinking. Sometimes it seems to me that people shirk this task more than any other. Mental laziness is a sore evil under the sun, and one far too common.

Now I am going to mention three political remedies for business depression, which have been persistently urged upon the attention of the American people, but which seem to me to be fairly classed as quack remedies. I am going to speak plainly with regard to them, but I hope to say my say without offense even to those who hold antagonistic views. I ask no one to accept my view until it has been tried in the crucible of their own best thought and proven worthy of acceptance.

These are the three: "Free trade," "free silver," and "the single tax," and which is the greater I cannot tell. It may be suggested in regard to them all that though they have been urged with great persistency, they have been so emphatically rejected that there is no need of wasting any time in their consideration. But their advocates refuse to be discouraged, and declare that they will continue their advocacy until they win a favorable decision. So it would seem that we have got to hear more of them whether we wish it or not.

Free trade is the first remedy I call up for consideration. The name has an alluring sound. We all like the word "free." It has very pleasant associations for us all. It is a good word, but one that is subject to a good deal of abuse. That which it represents is not a good thing under all conceivable conditions.

Neither you or I would enjoy being turned into an enclosure with John James Corbett or Bob Fitzsimmons, with perfect freedom to pummel our antagonist until he cried for mercy.

Civilization exists for the promotion of beneficent freedom and for the restraint of freedom to work injury.

Free trade means unchecked, unrestricted, uncontrolled competition in production and exchange.

Competition is another agency which has both beneficent and destructive functions, and the concentration of the forces of production which has been brought about in the past few years, has immensely increased the activity of its destructive function. To kill off business rivals is one of the leading objects of business management. I suppose that in many cases this is a necessity, and promotes the general welfare, but the strong tendency of such a policy is to go beyond necessity and sacrifice general welfare to individual greed.

When it reaches that line some means must be found by which it can be held in check, and this seems especially important in the matter of national competition.

I believe that the national organism is one of transcendant importance, that its welfare should be an object of profound solicitude to every citizen, that the progress of the race is to be secured by securing national progress, and that the highest duty of every nation is to care for its own. This nation is entrusted with natural resources of soil and mine and stream and forest which it belongs to us to develop and bring into the service of the race, and if we fail in this task we shall justly go the way of those who have preceded us in this magnificent possession, and the "Lord of the vineyard will let out his vineyard to other husbandmen who shall render the fruits thereof in their season."

Not only has this great nation been put in possession of these boundless natural resources, but in the great and versatile intellectual power of its people it has another resource the magnitude of which cannot be measured. And these two resources, or classes of resources, depend for their development, the one upon the other.

Our natural resources have lain dormant for uncounted ages until intellectual power was brought to bear upon them, and while we think we have accomplished much in the work of their development, we have as yet made only a faint beginning.

On the other hand, intellect can be developed only as it has something tangible to work upon. I think one explanation of the intellectual darkness of the middle ages is to be found in the unreal nature of the problems which then occupied the minds of the intelligent and educated classes.

A pen picture of the great University of Salerno, in Italy, represents a scholar posting in public certain propositions which he considered important, and upon which he challenged discussion, and one of them was this: "Whether angels, in going from place to place, pass through the intermediate space?"

No wonder the ages were dark when the best thinkers occupied themselves with such unfruitful themes as these. Light and power and the uplifting and broadening of life come only when thought is directed to more practical matters.

The absence of any regulation of trade may be good for the industrial bully of nations, just as the absence of the policeman

may seem good for the physical bully in any group of men, but for the nation or the individual which is not the bully, such a measure of protection as will enable them to develop the resources which are rightly theirs, ought to be demanded and freely accorded. I know the taunt is often thrown at those who believe in protection for the industries of this nation, that such a demand is an unworthy confession of weakness on our part, but when it is considered that a capacity and a willingness on the part of great masses of the population to live degraded lives is an element of strength in this industrial competition between nations, the taunt loses its force and is robbed of its sting.

Come up "Free Silver" and make your bow before this audience and let us get a view of you and make an estimate of your ability to serve us in combating hard times. You too have appropriated that alluring word "free" as part of your cognomen and you have a record of long and useful service to fall back upon. The trouble in your case seems to be that we have a much more efficient servant for the work you have been doing and that you two have fallen out with each other and won't work together. It seems to be a simple necessity that you should give up the work of measuring values and go and hunt some other job. And you needn't feel bad about it either, for there is plenty of good honest useful work to be done by you in other lines.

And now having said this much to you, we will excuse you for a moment while we have a little talk about you.

The fundamental fallacy in the argument for free silver is to be found in the assumption that money should bear a stable relation to product.

The exact reverse of this is true. Things are worth what it costs to produce them, and with science and industrial art at work as successfully as they have been for the past fifty years to reduce cost of production, it ought to be enough to condemn any measure of value that it fails to show this reduction. Silver does not show it, because the cost of its production has been reduced in just about the same ratio as that of the great staples of commerce. Gold does show it, because the cost of its production has varied but slightly. Gold and silver are both plentiful and very widely distributed.

All the world wants of either it can have by paying cost of production. In the case of silver, this seems to range between

sixty and seventy cents per ounce. In the case of gold it doesn't vary much from $20 per ounce.

According to the sacred formula of the advocates of free silver it takes sixteen times as much of that metal as of gold to make a dollar, and when made unless a gold dollar stands behind it it can only do the work of a half dollar. It seems as if nothing more were required to show its inferiority and its utter inability to help us in the fight against hard times. There isn't any mystery or magic whatever about the matter. Either metal might be used but they will not work together and we want the best. Of the two, silver being the more fluctuating, would lend itself to the uses of gamblers more readily than gold and it certainly does not contain any element which could operate as a cure for hard times.

A failure to realize the fact that the cost of production is the factor which determines values, is largely responsible for the hardness of the hard times from which we are now suffering.

A great many people have seemed to reason in this way. Here are those tremendous economies of production which I can utilize, and assuming that prices can be maintained even approximately my fortune is made. A few who thus reasoned and who were first in the field did realize fortunes, but the great multitude found out to their sorrow and disappointment that too many were following out the same line of reasoning, and when their products were ready for market that market wore a very different aspect from what it did when they entered upon their enterprises.

The market broke down. How often we hear that remark. They tell about structural weakness in some of our new war ships, but there is a structural weakness in our system of distribution which it won't do to go on patching forever.

But I am getting a little away from my right line of thought. What I wished to bring out was the fallacy of any reasoning which assumed that great economies of production could be made to inure permanently to the benefit of the producer. He may hold on to them for a little time but eventually and before very long, they pass over to the consumer. And there is where they rightfully belong.

The last of our trio of quack remedies for hard times comes to us under the title of "The single tax." It hardly seems worth much notice. After looking over the broad field of our country its advocates selected the little State of Delaware as

the most promising locality in which to concentrate their energies with a view to bringing about an acceptance of their doctrine. They made a very active canvass, attracted much attention by a kind of pseudo martyrdom, spent $20,000, and secured about 1,000 votes.

Stripping the principle which they advocate of the misleading disguise under which it masquerades and you find it to be confiscation, pure and simple.

All land-owners are to be deprived of the property which they hold in that form, and reduced to the state and condition of tenants. The chief argument urged in favor of this proposition seems to be that the income from the property thus confiscated would pay the expenses of government and therefore owners of property in other forms would be relieved of all burdens of that nature. There goes with this argument a theory that something in the nature of land renders it an improper subject of proper ownership, but neither theory nor argument seemed to impress the people of Delaware very seriously. Considering how readily unthinking people follow a new and self-confident leader, it is not surprising that the scheme secured a thousand votes; and the fact that it received no more is evidence of the general good sense of the people of Delaware. That good sense seems to have decided that the title to property in land rests upon the same basis as the title to any other form of property, viz.: that it is the best arrangement for the general good.

Evils resulting from it are due to excessive, rather than normal, holdings and these evils must be cured by remedies limited in their action to the evils, and not striking at evil and good alike. Before leaving this phase of the subject I wish to say a word concerning a remedy of a different nature.

It is called "Economy," and as I speak its name I feel that I must be extremely careful in what I have to say about it. For I am not going to give it unqualified approval. Perhaps if I could accurately define it according to my own notion, I might wholly approve it, but as it is many times understood and applied it might do harm rather than good. True economy, I would say, consists in a wise use of one's possessions as distinguished on the one hand from extravagance, which wastes one's own means, and sometimes does not stop at that, but wastes the means of others as well; and on the other hand, from stinginess, which makes just as little use of one's means as possibe, either good or bad.

The trouble in talking about economy is that the term is often stretched in meaning and made to cover stinginess as well. Now stinginess won't help cure hard times. Not a bit of it. For, as we have seen, the great underlying cause of hard times is an inadequate distribution of products, and stinginess would tend to limit that distribution still more.

Going without many things when necessity requires it, is good discipline. It brings out the soldierly elements of strength, endurance, courage. But going without desirable things under the dominion of the miserly, stingy impulse makes a mental and moral cripple of him who practices it, and reacts unfavorably upon the general welfare.

I shouldn't wonder if my audience thought it full time that I gave some attention to genuine remedies for hard times. If they do so think, I am fain to agree with them, but I realize as well as they, that this is the most difficult part of my task, and one in regard to which I must speak tentatively, and give suggestion rather than prescription.

I am going to make three of these suggestions, two of which will be in the line of public action and one in the field of private conduct.

My first is of an exceedingly radical nature and may startle you. It is nothing less than a stern, sharp, effective, legal limitation upon the accumulation of immense fortunes in the hands of individuals. I have very little expectation that this suggestion will be received with favor. It is probably quite a long way ahead of time and the practical difficulties in the way of carrying it out are many and great. But for all that it is a real remedy for the evil we have had under consideration, and I think you will find that sooner or later it will have to be applied.

Here is the line of argument. Hard times, that is excessively hard times, come to us because of inadequate distribution of abundant products.

There is wealth enough in our country certainly, and probably in the world. There is a sufficient reserve of product to carry us safely through the periodic slack of business which constitutes normal hard times. The trouble is that very much of this accumulated reserve has, in fact, we need not now inquire how, settled into reservoirs or pools, where it stagnates and works no good to any one, while over broad spaces of the field there is scarcity and want and haggard suffering. If I were managing an irrigation plant and had at command a

sufficient amount of water to make my entire field fruitful, but should detect a tendency in the life-giving flood to settle in excessive quantity about some few plants giving them an abnormal growth of stalk and foliage but with very little fruit, while over much of the field the plants were stunted in growth and fruitless also for lack of water, my first move would be to build a barrier to check the excessive flow of water where it was doing no good, and afterward I would try to open channels for it to flow where it was needed.

I know that it seems shocking to the American mind to suggest that anything be done by law to prevent any man from accumulating any amount of wealth by almost any conceivable means, so long as he doesn't openly murder, rob, and steal, for that purpose.

As a people we are probably the most abject worshipers of mammon on the face of the globe. I think the explanation is that nearly every one of us carries in his breast the hope that he may be among the favored few who are to be the possessors of great wealth.

Even if we have lost the expectation of this, that other element of hope which is named desire still remains. We wish we were rich, and the wish is so pervading and strong that it obscures our perception and deflects our judgment from the right line of inflexible justice and a supreme regard for the good of all.

It is because there is, in each one of us, a possible or an imaginary millionaire, that the actual millionaire undergoes an apotheosis, and is placed in a category different from ordinary human beings. He may be feared, he may be hated, but he and his possessions are sacred and must not be touched by rude hands.

This feeling was well illustrated some years ago when the late Jay Gould, of sainted memory, gave the sum of $10,000 for some worthy object. Some man made the inquiry, thoughtless or thoughtful as you may choose to regard it, "How did Jay Gould get that money?" and instead of receiving a plain answer to a simple question, giving the information sought for, criticism and censure were freely visited upon him from almost every quarter for asking such a question. It was enough that Jay Gould had the money. How he got it was a matter not to be inquired into. But, setting all considerations of a personal nature aside, this may be said in general concerning all great personal fortunes.

Their possessors have never given any adequate equivalent for them. We speak of them accurately as acquired, not produced or earned. They are acquired from other people, made up of contributions furnished in ignorance or from necessity, and for which either no equivalent or only a partial one is returned. Is there anything sacred in fortunes so acquired?

Going a step further and supposing it possible to imagine a man so powerful for good that he could render a full equivalent for the greatest fortune, why should he insist upon receiving his all in money or some form of material wealth? Why not take part of it in other coin, love, gratitude, appreciation, a little of that blessedness which is won by giving and not receiving?

The matter ought not to be considered primarily in its personal aspect. I am very far from assuming that rich men are, as a rule, bad men. So far as I have personal knowledge of them, and that isn't very far, the reverse of this is true. I do not hold them as a class personally responsible for the bad condition of things which flows from their excessive accumulations. They are in the whirl and grind and strife of business, and in self defense and for self protection are compelled to use current business methods. I believe that many of them would experience a genuine relief if a general limitation of accumulations were enforced upon all.

But I must not follow this thought any further, and turn to my other suggestion in the way of public action, which is in brief the requirement of publicity in business operations. The main purpose of this requirement is to give the corrective power of public opinion a chance to work in transactions where corrective work is needed.

The longer I live the more I am impressed with the remedial virtue of public opinion. It is stronger than law and will work where law cannot. In comparison with it, law is a clumsy and bungling device, wasteful of power, and uncertain and unsatisfactory in results. But public opinion can work only in the light. So long as transactions which it would condemn can be hidden, they escape its penalty and the evil of them remains uncorrected.

We have made something of a beginning in this line, by requiring of fiduciary institutions periodical publications of their business operations and condition, and by subjecting them to investigation by official examiners. I believe that the appli-

cation of this principle can be very largely extended and our methods of work under it immensely improved.

The element of trust enters largely into all business operations, especially in the form which business is now assuming of concentration and aggregation. More emphatically than ever before is it true that business managers hold in trust the interests of others, and they cannot rightly declare that it is not the business of any one else to know anything about their management. I think it not difficult for anyone to call to mind instances of business disaster which would have been prevented if full publicity had attended the operations which brought them about.

The fact that the business of the farmer is conducted in open view of all who choose to look and that no concealment of his operations is practicable, is sometimes spoken of as a disadvantage to him; and in a narrow, selfish view of the subject it may, indeed, be such; but it is a disadvantage which he may well wear upon his breast as a proud badge of distinction among men. If he makes mistakes, others, as well as himself, may learn from them. If he wins success, others may follow the same path and share the success to which it leads. He may be prevented by the publicity of working which nature enforces upon him, from levying unearned tribute upon his fellow men, but let him not regret any loss which may come to him through this inability. The real cause for regret is that in other lines of business the same publicity is not enforced by nature's laws or by the laws of man.

But public action through the agency of legislative bodies is slow and uncertain, and in the lines suggested would meet with tremendous opposition. While waiting for it, or in despair of accomplishing it, or without faith that any good can come of it; what, if anything, is left for the individual to do to prevent hard times or to moderate its severity so as to protect himself and those dependent upon him from its worst effects?

Well, he can take the fact of hard times into his scheme of life and plan of business, and make due allowance for it. He will hardly live his life through without some experience of it, and if he realizes this fact he need not be caught by it wholly unawares. When everything is booming, understand that, in the nature of things, this condition cannot last, and be in some measure prepared for the change when it comes. Don't fight the battle of life without reserves. In a Cali-

fornia town, last winter, a man was describing to me the boom experience which they had gone through, and he summed it up in these words, "We were living in a fool's paradise, and thought it would last forever." Don't locate your residence in a fool's paradise. This man had saved a humble home from the wreck, and was getting a living by grubbing oak roots from the ground and selling them for fuel.

Another man in the same place told of making $22,000 in eight months in boom times, but he was living in an extremely modest way, would sell his horse and carriage very cheap, and objected to a city ordinance requiring him to curb the front of his lot, because he couldn't afford the cost.

It is pitiful to have hard times catch you without any preparation. Have some reserve waiting to help in time of need, some refuge prepared to which you can fly when necessity is upon you. And when hard times does come, meet it manfully. Be strong and of good courage. Don't whine. If wealth vanishes, don't throw after it that which is of infinitely more value than wealth. Rather make the loss of material wealth a stepping-stone to higher life, a means by which you may acquire the more enduring riches.

The underlying thought of the remedial suggestions contained in this discourse is the thought of limitation, the avoidance, and, if necessary, as it seems to me, the enforced avoidance of excess on the one hand in order that pinching scarcity and the wretchedness which comes from it may be avoided on the other hand. I know that this doctrine is not palatable to an American audience. It runs counter to the extreme individuality which is characteristic of us as a people. But I see no other way to cure or prevent hard times.

Can you point out a better way? Or isn't there any cure, and must we accept hard times as something inevitable. It is a hard question, a difficult problem to solve. I have made my contribution to it the best I am able to, and I leave it with you for thoughtful, earnest consideration and for action, if you can see your way clear for action.

[Music.]

Gov. Coffin. I am glad now to have the pleasure of introducing one whom I know does not spend all his time on a "deserted farm," to talk to us on the question of "Deserted Farms"; one who has had experience, and understands the

question which he is to discuss. It affords me much pleasure to present Mr. Hinman, who will speak on that subject.

THE DESERTED FARMS OF NEW ENGLAND.

By R. S. Hinman.

There has been so much said and so much written of the abandoned farms of Connecticut and the other New England States, of late, that my theme may seem a little worn, but I believe there are phases of it worthy of our consideration for the few minutes allotted to me.

Some years since I had occasion to transact a little business with a Dutchess County, New York, farmer. Learning that I came from Connecticut he expressed his surprise at the thriftiness of Connecticut farmers.

He owned a hundred acres of land in what is known as the Oblong Valley, worth a hundred dollars an acre, and only got a living, but over in Connecticut the farm-houses were painted, picket-fences separated the front yard from the highway, and there was a general air of thrift about the premises, while, so far as he could see, there was not so much decent farming land in the whole township as there was on his farm. To get the full force of the gentleman's surprise one needs to drive through the richest part of Dutchess County, in which the Oblong Valley lies, and then across into Connecticut. Ever since I have been familiar with that country I have contended that the Knickerbockers that sailed up the Hudson and settled along its shores took up the land as far east of that noble stream as they considered it habitable, and left the rest for Connecticut.

A few months ago I came across an article in a popular magazine written by a Southern woman that evidently considered herself better posted. Its title was "The Gray Cabins of New England." The impression that one not conversant with the facts would get from this good lady's description would be that the farm-houses of New England are little one-story, unpainted affairs, in which, in these latter days, there commonly dwell one or two lonesome old maids or a morose old bachelor and his still more morose old-maid sister. During the day, when their dyspepsia will allow of labor, these unfortunate beings do what they can to keep body and soul together, and when night comes they hug a fast-cooling stove

while they brood over the misfortunes of their fallen race. When, at last, death ends their sufferings, all that they can expect is that the grass and weeds will be scraped away from a little spot of ground in the nearest graveyard, a hole dug, and the last sad rite performed over a descendant of the Puritans.

That the author of the article was as ignorant of her subject as one of the poor Southern whites, with whom she is undoubtedly familiar, is quite true, but I doubt whether she really intended to libel the good people of New England. She had read, undoubtedly, much about the abandoned farms of New England, and drew upon her knowledge of farm life among poor people and her imagination for a description of the farm-houses of New England and the people that inhabited them.

But we must allow that we have deserted farms. I have in mind a piece of land facing the northwest, so full of boulders and fast rocks that, upon an average, I doubt if a furrow five feet in length could be continuously turned, and that never had anything but a thin, poor soil. A gentleman now living, that in his old age rides a bicycle for exercise, has told me that when he was in his teens he and his brother-in-law planted that field with corn on shares, the owner, if I remember aright, taking half the crop. Those two young men possibly got fifty cents per day, boarded themselves, and were content. That field has never been tilled since, and it is not likely to be, unless in the distant future there comes a time when fifty cents per day is the best wages a young Connecticut farmer can earn and board himself. God grant that such time may not come in our day. Within sight of this field that I have been telling you of there lives a pioneer. Some ten or twelve years ago he bought a stump-lot for two or three dollars per acre, and put up, as a dwelling, a cross between a wood-chopper's shanty and a Western dugout, and what he calls his barn. The entire outfit of buildings, aside from his own labor, did not, probably, cost him fifty dollars. The place is half a mile through sprout-land from the nearest highway, and here he and his wife and one son live. He has plenty of muscle and energy, and now has the stumps and stones cleared from a patch of ground as big as a well-to-do farmer's garden ought to be. His little new-land farm is, however, wonderfully productive, and, besides growing vegetables for the family, it supplies him with onions, celery, strawberries, and

other things that he takec to market and exchanges for rum and molasses, and such minor articles as he and his family need.

His success shows that no land in Connecticut need be abandoned if men can be found willing to work as the early settlers of this country worked, and live as they lived.

But some one may tell me of easily-tilled land, easily accessible, and, apparently, once productive, that has long been unused and is now grown up to brush. I grant it. The very fact that it was so easily tilled and so easy to get at worked its ruin. Taking crop after crop from any land and returning nothing will in time render it fit only for abandonment. Such land may be restored by fertilizing, but the cost is too great for competition with cheap new western land. When Uncle Sam gets through giving us all a farm such land is liable to again be cleared up, and, if left long enough to itself, nature will to some extent restore its fertility. Aside from the rough land unsuitable for farming at the wages a farmer of to-day can earn, and the land that has been despoiled by covetous owners, there are, undoubtedly, many thousand acres of excellent pasture land in Connecticut practically abandoned. When a Connecticut farmer could loan his money to a Western competitor at eight or ten per cent., it was a great temptation to let the brush grow on his own farm and take his interest, rather than hire help to cut his brush. When Connecticut passed a law allowing the registration of notes and bonds at a low rate of taxation, the farmers of a Litchfield County town sent to the state treasurer's office something like $60,000 worth of evidences of Western indebtedness. Had that money been used in cutting hard-hack, improving highways, and maintaining the value of the real estate of the town, there might not have been so great an apparent profit, but the town would have been more than sixty thousand dollars richer now.

If two manufacturers were to start in the same village at the same time, and one loaned his profits to the other to keep up and enlarge his plant, while the lender allowed his buildings and machinery to rot out and wear out, it would take but a few years to make one a prosperous manufacturer, while the other could take what was due him and abandon his plant.

Very many Connecticut farmers have for years past been doing altogether too much in the way of booming the business of competitors.

Said a friend, who had read that I was to talk to you of the deserted farms of New England, "The subject is a good one, for there are scores of deserted farm-houses and cellars where farm-houses once stood, go where you will in Connecticut."

This is quite true, but it does not follow that we are the poorer.

Let me give you an example. In my boyhood days there stood, near a by-way that I travel over in going to an outlying farm, what would be known as a farm-house. The owner had a little farm, kept a horse and cow, possibly two cows sometimes, and made and mended boots and shoes. The old shoemaker died years ago, and shoemaking, as an individual industry, died about the same time. The farm-house is gone also, only the site remains, and the little farm is deserted. I have offered double what the house, barn, and farm brought the last time it was sold, about thirty years ago, for the land alone, but the owner, employed in a nearby city, thinks he may come back to the country to live sometime, and prefers to let it grow up to brush in the meantime.

Again, it must be remembered that it required more people to raise the same crop on the same land years ago than now. Mowing machines, horse-rakes, and cultivators take the place of men, but do not require farm-houses. The man that sits on a mowing-machine to-day gets double the pay that the old scythe-swinger got, but he and a pair of horses can do as much in a day as the dwellers in half a dozen of the houses that are gone, because not needed under present conditions. When you allow for the farm-houses, once plenty all over New England, occupied by shoemakers, wheelwrights, tailors, and people engaged in other industries, that are now concentrated in our cities and boroughs, and for those occupied by people, who, living as farm-help lived fifty years ago, could plant a rocky hillside with corn on shares, or work for fifty cents a day, you will account for all the old sites, and when you find a farm-house fit to live in or a farm, upon which a living, as we live now, can be made, deserted, it is because the owner's profit or pleasure takes him away from it and he does not choose to sell.

It is the misfortune of Connecticut that, through mismanagement, many hundred acres of her soil have been made unproductive, but it is not her misfortune that her citizens

can live more comfortably than of yore and are not compelled to wrestle with her rocky hillsides and wornout fields.

While a vast amount of the abandoned land of Connecticut can, without doubt, profitably remain abandoned, there is much that the frugal, industrious man can reclaim. Farms that the owners have left because they had obtained more profitable employment or because they were not fitted for farmers or farm life, although they may look somewhat untidy, owing to dilapidated buildings and fences, and the growth of brush and weeds, are, I believe, if they can be bought at their value, safer as investments than much of the new Western land.

While there are mortgaged farms in Connecticut and farmers in debt, failures are rare in comparison with those of persons engaged in other industries. Connecticut farmers are not, as a class, asking for a fifty-cent dollar to pay their indebtedness with, and they are not asking for laws to hamper the collection of honest debts. While I have known of a few cases in Connecticut where farms have been taken by foreclosure, it has always been under conditions that would have produced a like result, whatever business the owner was engaged in.

While the state would be surely richer if frugal, industrious people bought and reclaimed our abandoned farms, this is not a matter that should specially interest us as farmers. When dull times came on a few years ago four abandoned farms within two miles of me were occupied by purchasers or by tenants who had been thrown out of profitable employment. To-day, instead of buying farm-products of me or my neighbors, these people are selling in competition with us. Two of these farms are occupied by foreigners, and, as they live economically, and all, men, women, and children work, they can undersell me. This may be an advantage to citizens of Connecticut who buy farm products, but I fail to see where my profit comes in. The other two farms were bought by men who have money to burn. They are both, as yet, customers of ours, and I doubt whether they will ever be able, with profit to themselves, to sell farm products at less than I can.

If the taxable value of the property is increased, the state is benefited, but, as taxpayers, our share is minute in comparison with what we lose by the competition, as producers, of the industrious, frugal class of occupants of deserted farms.

When deserted farms are taken by gentlemen to whom farming is a fad and who look upon the farm as an amusement, like a yacht or a stable of trotting or running horses, we can all get some benefit. They are quite sure to spend money and benefit the laboring people in the neighborhood, and equally as sure to make experiments that observing neighbors can derive benefit from without expense to themselves. This class of purchasers of abandoned farms should be welcomed and encouraged by everybody. Money spent in increasing the value of Connecticut real estate is, in my opinion, much better spent than in yacht-building or horse-racing.

As patriotic citizens we may advocate measures for the reclaiming of abandoned land by frugal, industrious people, but, as farmers, looking to our own interests, we should, instead, advocate the starting of every mill-wheel, and the building up of industries that will give us a market for what we produce.

Gov. Coffin. I have now the pleasure of introducing Mr. Edwin Hoyt, who can teach us on any subject upon which he is willing to undertake to instruct us, who will present a paper on "Stable Manures or Commercial Fertilizers."

STABLE MANURES OR COMMERCIAL FERTILIZERS.

By Edwin Hoyt, New Canaan, Conn.

Mr. Chairman and ladies and gentlemen: Brother Hubbard has said that sweetness will be sweeter after we have tasted of the bitter; and my subject is one, or, at least, the materials of my subject, which does not possess sweetness. That I leave for these pinks and roses and the fruits to extract, without which we cannot have them. What I have to say to you I give simply from a farmer's standpoint.

One of the most important yet most perplexing and difficult problems the farmer of the present day has to solve, is that relating to manure. To plant a crop without some kind of manure or plant food is, as a rule, to plant and cultivate for a small crop, without any profit, perhaps, as well as still reducing what little fertility there is left in the soil. To purchase stable manure or other fertilizer is an expense, of course, and many farmers believe that the increase in crop and profit

is not sufficient to warrant the expenditure; while many other farmers do believe that it pays to buy one or the other, or both, as is clearly demonstrated by the millions of tons sold annually to our farmers — and it is to this class I belong. To prove that it does pay the farmer to buy manure of some kind, to help out his own supply, is not the purpose of this paper. I would simply say, however, that, as a class, those who are most careful to save their yard manure, and who also buy and use the larger quantities of fertilizer, are the farmers who are the most successful and prosperous.

My object in this paper is to tell you which I consider the more economical, as well as profitable, for the farmer to invest in, for what plant food he lacks over and above that of his own production, viz.: stable manure or commercial fertilizer. By the latter term I refer to such as ashes, cotton-seed meal, bone and mixed fertilizers compounded by manufacturers, as well as the chemicals which enter so largely into the composition of many of the so-called commercial fertilizers.

In the first place, I would say to every farmer who keeps stock of any kind on his place, to make and save in as good condition as possible, all manure made by such stock, but for whatever plant food you may lack each season, invest your money in commercial fertilizer of some description, judiciously selected, and not in stable manure, unless it can be purchased very, very cheaply. The soil itself is merely a medium through which the farmer, by intelligent labor and attention, is enabled to reap a harvest from the seeds he has sown. If there is not enough plant food in the soil to insure profitable results, then it must be supplied, and it should be in the most available (as well as in the cheapest) form for the plant's use, and this is not, in my opinion, to be had from stable manure. We should study to feed the soil for the various products we wish to secure with as much intelligence as a good dairyman feeds his cows to produce certain results; for the cow, like the soil, is merely a medium through which certain unpalatable forms of matter are changed into edible food. Some coarse or bulky food is necessary for the cow, but for most economical and profitable results, a balanced ration, containing more or less concentrated food, is better than all hay or all cornstalks, or both together. Now then, for the soil, let us consider the two plant foods — stable manure (made by horses or cows), as against commercial fertilizer. By reference to the

1890 report of the Connecticut Experiment Station, I find an analysis of cow manure, which reads as follows:

Water,	82.42 per cent.
Organic or volatile matter,	15.33 "
Ash,	2.24 "

From this it is seen that in every ton of this manure there is 1,648 lbs. of water, which is of no use whatever, and if this manure has to be hauled any great distance, the enormous weight of water adds materially to the cost. The chemist finds that there is 15.33% of organic matter, which is equal to a trifle over 306½ lbs. to the ton. In this quantity of organic matter he finds 2 pounds of available nitrogen, as ammonia, and 6.2 lbs. of organic nitrogen which is to come out of the 300 lbs. of organic matter at some future time. From the 2.25% of ash there is (in a ton) 4.1 lbs. of phosphoric acid, also 6 lbs. of potash. This represents a total of 18 lbs. of plant food in a ton of manure, *and the balance of 1,982 lbs. is trash.* This manure is valued by the chemist at $1.66 per ton.

Regarding horse manure, I find, by referring to a report of the Cornell (N. Y.) Station, the following analysis:

Water,	48.69 per cent.,	(in a ton 979. lbs.)
Nitrogen,	.49 "	" " 9.8 "
Phosphoric acid,	.26 "	" " 5.2 "
Potash,	.48 "	" " 9.6 "

With a valuation of $2.21 per ton.

The horses from which this manure was saved were fed on hay, a mixture of oats, corn meal, and wheat bran, and had bedding enough to absorb all the urine. At this same station they analyzed the cow manure made by feeding hay, ensilage, beets, wheat bran, corn meal and cotton-seed meal, worth $2.02 per ton. You will observe that the feed given both horses and cows was, in part, wheat bran, and to the cows, cotton-seed meal, both of which articles are rich in phosphoric acid, nitrogen, and potash, thus making the manure show a comparatively large percentage of these ingredients, and, consequently, of higher value than it would be were the animals fed on poorer food. So it is safe to say that the average value of a ton of stable manure, whether made on the place or bought in a village or city, is not worth, on the basis of a chemist's analysis, over $1.50 to $1.75.

Now, do not let us be misled by the value given stable manure (or commercial fertilizer either) by the chemist, for

although he, undoubtedly, estimates correctly from his standpoint, there are other matters to be considered by the farmer when figuring the actual worth of a ton of plant food. We must remember that the chemist has found phosphoric acid and potash inside of a few moments by burning, while the plant in the soil will not be able to secure these chemicals from the manure until the same process of *burning* — which is decomposition — has taken place, and this, of course, requires more or less time. It is a well-established fact that what the plant requires the farmer to add to the soil to give it its development is nitrogen, phosphoric acid, and potash, and it requires these as soon as its feeding roots are old enough to absorb them. Suppose there is neither phosphoric acid nor potash in the soil when the crop is planted; how much of these two most essential chemicals would the plants get the first year from green stable manure? Very little. If the soil already contains phosphoric acid and potash, we will, by the addition of stable manure, get a good crop in favorable seasons from the ammonia it contains. But a larger crop may be had at a less expense by applying less stable manure and adding ashes or muriate of potash and dissolved bone black, which would feed the plants at once, or soon after the first rain. That stable manure has no value other than the nitrogen, phosphoric acid, and potash it contains, I do not say. I know it adds humus, and has a mechanical effect upon the soil (which should be considered in estimating the value of stable manure), yet I do say I think we can supply all the humus the soil needs by plowing in heavy turf or clover, and that this method is much cheaper than buying stable manure, containing 1,000 to 1,500 lbs. of water to the ton, if it has to be drawn any great distance — unless it can be had for the drawing only, or bought very, very cheaply. A farmer, by judiciously using what manure is made by his own live stock, and plowing in turf sod or clover, together with the use of concentrated and available plant food, such as is found in commercial fertilizers, will produce larger and more profitable crops, as well as increase the fertility of his soil faster than by using stable manure alone. Nitrate of soda, bone-black, dissolved rock phosphate, muriate of sulphate of potash, or ashes are all available and active plant foods, and are to the plant what oats are to the horse, corn to the pig, and wheat bran and cotton-seed meal to the cow.

I see by the 1890 report of the Pennsylvania Station that a ton of clover hay is given a manurial value of $9.07, while

clover hay is quoted in the New York market at from $11 to $12 per ton. This gives it a commercial value of $2 to $3 only over its manurial value, which is a small amount for harvesting and marketing. Would it not be more economical for a farmer, if his soil needs humus (as most soils do), to plow in his clover than to cure and sell it at $11 to $12 per ton, and then buy stable manure to secure the same results as would be obtained by plowing in that clover? If undecomposed stable manure alone is used there is often much danger of its doing the crops more harm than good, and especially is this the case when the season is a dry one, and the application made to a dry soil. The reason of this is that stable manure is by no means a well-balanced fertilizer, or, in other words, it contains too large a percentage of nitrogen, and insufficient phosphoric acid and potash. This excess of nitrogen, with the straw, causes, especially in dry weather, and when applied liberally, the plants to dry up to a certain extent. The soil would, of course, after this liberal application of stable manure, be in better condition for the following season's crop, but the nitrogen it contains, which is estimated as 15 cts. per lb., gives the stable manure its greatest value, from a chemist's standpoint, and this is practically thrown away after the first year.

The analysis of the horse manure, as quoted in the Cornell Station report, shows that of the $2.21 value per ton, $1.47 is for nitrogen, and this manure was made at the station, where nothing was lost. How different is it when the farmer buys it from stables, where it is thrown out to the weather, ferments and burns, and is, perhaps, carted to the farm, where it is again piled up, and, thereby, made to again pass through the same heating process, thus losing all, or nearly all, of the $1.47 worth of nitrogen there *may* have been in it at first. With the ammonia expelled we have left in each ton 74 cts. worth of phosphoric acid and potash, locked up in the straw and excrement, and this will be available only *at some future time.* In view of the fact that $1.47 of the value of a ton of horse manure is in the nitrogen, it is very important that this manure be so handled that the value will not be lost through exposure, heating, rains, or a too heavy application at one time. If a ton of stable manure is worth only $2.21 at its best, and is bought at $1 to $1.50 per ton, and carted one, two, three, or more miles, thus adding $1 to $1.50 per ton more to the cost, according to distance hauled, altogether making it cost from

$2 to $3 laid down in our field, what have we left for profit, and especially so when the nitrogen is largely expelled before it is put into the soil for the plant to feed upon, as is the case with most all bought manure? With the most careful handling, nitrogen, phosphoric acid, and potash in stable manure is the most expensive form in which they can be purchased, as well as the most unavailable as regards phosphoric acid and potash.

The more I study this question of stable manure, and think of the thousands of loads we have hauled from Norwalk to our nursery, a distance of four or five miles, and the money we have paid stablemen besides, wearing out faithful and patient horses, I bitterly reproach myself for not having given the matter more careful attention and thought long ago. However, "ignorance is. bliss," and as I thought it was all right, was entirely satisfied. We are now using considerable concentrated fertilizer, buying the chemicals and doing our own mixing. By this method we are enabled to supply the plants with more or less available plant food as the particular varieties require for their best development, or, when stable manure is used, we balance its proportions with certain chemicals. We keep about twenty horses, 35 to 40 cattle, and 25 to 30 hogs, from which we make all the manure we can, and with this we mix the chemicals, which we buy in lots of from 25 to 30 tons, and wherever we have used our homemade chemical fertilizers we have seen good and satisfactory results.

Perhaps I have already said enough to convince you that I am not an advocate of buying stable manure when it must be bought or hauled from a village or city. I am, however, in favor of using it so far as it may be done at a profit, but this cannot be done, in my opinion, when it has to be freighted or carted to any considerable distance, unless it can be had for the transportation, but even then I would want to look it over very carefully before agreeing to take it away free gratis, as unless it was first-class in every respect, and the transportation charges under $1.25 per ton, it would not be a good investment in the end.

Now, a few words regarding commercial fertilizers. There are many farmers who say the manufactured article is of no use, and they will buy no more. Undoubtedly, they have considerable grounds for their belief. Perhaps the goods bought have not been as represented, excepting that the farmer may have received a ton of some kind of "stuff" for a com-

paratively small amount of money, and disappointment, failure of crops, and loss have followed; consequently, faith in commercial fertilizers has been reduced to the zero mark in their case. Let me warn you not to buy a fertilizer because it is offered cheap per ton. It is essential that if you are in the market for fertilizer that you accept only that with a guaranteed analysis, which will place the chemicals contained therein at a cost of not less than $30 per ton, figured on a basis of the quotations of the chemicals at the current time. Then learn, if you can, from what the nitrogen and phosphoric acid is produced, as many times the nitrogen and phosphoric acid are in an unavailable form. In applying such a fertilizer, make a liberal application, using, say, from 1,000 to 2,000 lbs. per acre, according to the crop to be planted. This will cost from $15 to $30, or more, according to the plant food contained in it; yet, this is not one-half what it would cost to fertilize with stable manure to get the same amount of phosphoric acid and potash. To give an acre of ground a fair dressing of stable manure alone, twenty tons, at least, should be applied. This would cost, all spread ready to plow in, not far from $2.50 per ton, or $50 for the acre. Now, for this $50 we have, of nitrogen, 196 lbs., of phosphoric acid, 109 lbs., and of potash, 192 lbs. With $50 worth of chemicals, we have of nitrogen, 90 lbs., phosphoric acid, 240 lbs., and of potash, 600 lbs. From this it will be seen we have only one-half as much nitrogen as with stable manure, yet enough, but of phosphoric acid two and one-third more, and of potash more than three times as much. Will fertilizers last as long as stable manure? is often asked. We say, yes, longer, money for money, as we have from two to three times as much phosphoric acid and potash as in stable manure.

In buying our chemicals we usually purchase nitrate of soda, dissolved bone-black or Charleston rock, and muriate of potash. At the prices paid last spring, one ton of this mixture, in correct proportions, for our use, cost us $32. Our experience with bone is not satisfactory; when used alone we fail to see any good results from it. We prefer dissolved bone-black for our phosphoric acid, as it is plant food at once. To obtain potash we generally use muriate of potash, although in seeding to clover we find unleached wood ashes very effectual and satisfactory. To spread them evenly on without an ash-spreader is somewhat of a difficult task, and adds somewhat to the expense of this kind of fertilizer.

From the use of our chemical mixtures we have found great satisfaction not only in the yield of the crop, but in the speed with which a field can be fertilized and planted. With a field of several acres to be fertilized with yard manure, say 25 to 30 loads per acre, it takes teams and several men to load and spread it, and the planting may be delayed a week; while in half a day the fertilizer, with a spreader, can be distributed and harrowed in ready for the seed, thus giving the crop the advantage of several days earlier start. From our large experience in using both stable manure and home manufactured fertilizer, we are satisfied that for us more land can be fertilized and cropped at a less cost and with a larger profit with fertilizer than with stable manure. In this experience we are not alone, as the following article by Mr. H. E. Van Deman, taken from a recent issue of the "Country Gentleman," will show:

"The New Jersey farmers and others have had numerous analyses made of New York and other city horse manure, with the result that in one ton was found, of nitrogen 10 lbs., potash, 6, and phosphoric acid, 10. This makes 26 lbs. of chemical manures in 2,000, the rest being trash and water. Now, the question arose in the minds of the thinking farmers, who, in some cases, had bought hundreds of tons of this bulky manure and hauled it on to their fields, Can we not dispense with this heavy work by growing the trash for making humus on the farm cheaper, and get these chemical manures otherwise? Some of them have become so well satisfied with it after a trial that they have abandoned the old practice of carting trash and water, and paying for it besides. They have found that by growing clover and other leguminous crops, they secured, at almost no cost, nitrogen from the air, and potash and phosphoric acid from 'the farm that lay under the old farm,' as Mr. Terry says, and by feeding them to live stock or plowing under, they got all the humus the soil needed. By purchasing some chemical manures in as concentrated form as possible, there was also a great saving. In fact, the value of the 26 lbs. of the three chemicals in a ton of the city manure, was just about equal to the price of the whole thing at the railway station, and the labor of hauling was a total loss. . . . . If nitrogen is not secured from the air, as it should be, buy nitrate of soda."

Long Island farmers, having had the same experience as

those mentioned in Mr. Van Deman's article, have abandoned using New York stable manure to a large extent, and are using instead thousands of tons of commercial fertilizer, and with an increasing quantity each year. This change by the farmers has caused New York manure to become, to a great degree, a drug on the market; so much so, in fact, that in many instances the collectors of city manure are paid by the stable owners for removing it.

In conclusion, I regret to say that I am unable to give any data wherewith to convince the skeptical of the advisability of purchasing fertilizer in preference to stable manure, nor have I any practical experiments to prove that two equal amounts of money invested in stable manure and commercial fertilizer, respectively, would turn out to be the better investment in the latter commodity after a trial of a term of years, yet, in my own mind there is no doubt about it. If, however, I have said anything which will cause the farmers to consider this question more seriously, and also bring out at this meeting a good, lively discussion upon the subject, I shall feel well paid for my efforts in preparing and presenting this paper.

Gov. Coffin. There is now opportunity for questions of either of the speakers who have addressed you this afternoon.

Mr. Hoyt. Do not be afraid of the questions. That is what we are here for. I presented this subject in such light that I was in hopes it would provoke discussion. I know how most farmers feel about stable manure, and how I feel.

Prof. Atwater. Some of the gentlemen happen, perhaps, to remember back as far as the time when certain scientific men, including one young chemist, used to come to these meetings and tell the farmers that chemicals would take the place of the farm manures. Then such doctrine as Mr. Hoyt has explained so forcefully was agricultural heterodoxy. I suppose those gentlemen have forgotten what I very well remember, the very kindly, but nevertheless rather supercilious aspect of the unexpressed criticism which was manifest here and there on the part of those same farmers. When we used to say, as chemists, that the 26 pounds of certain materials in that whole 2,000 was about all it was worth—though we did not go

as far as that — we were thought to be a very peculiar class of people. And now it comes about that the practical farmers themselves, and the most successful ones in Connecticut, tell us the same story. That young chemist, now grown older, almost wants to talk the other way to-day, and to ask Mr. Hoyt if he really believes that in dry weather the chemicals are just as good as the barnyard manure, or horse manure, and if what he has chosen to call "trash," or rather what has been called "trash" by some one else, whom he quoted, apparently with approval, is really trash, or whether the organic matter is not really quite valuable? I should like to have Mr. Hoyt's answer to that, and then perhaps I may crave the privilege of asking something more.

Mr. Hoyt. I do not profess or believe that I shall be able to cope with these professors. As I told you in the start, I am a practical farmer, and I know what results are produced. Now as to the question, "Will the crop be better produced from chemicals in dry weather than from stable manure?" I say, decidedly, yes. Of course, if that stable manure had been put into the soil long enough, so that it has been decomposed, so that the ill effects of it is not felt by the excessive quantity of nitrogen there is in it during the dry weather, then it is all right. But if the season is dry, the crop will be better with commercial fertilizers than with stable manure. And I know of experiments that have been made, and the facts have been given, where stable manure put upon the soil and the same land planted without any manure, that, in the case of potatoes, the land which had no manure whatever yielded a larger crop than that which had the stable manure.

Mr. Hinman. I always believe everything Mr. Hoyt says. I believe that; but I don't believe, that whatever the quality of the stable manure, whatever the quantity, that the result would happen if the manure was left on top of the ground. If it were put under, I think it might interfere with the crop. But put on top of the ground as a mulch, I don't believe any stable manure in the world will do harm. You cannot spoil

land with stable manure put on top of the ground. As to commercial fertilizers, my father used to say when I was a boy, he could carry sufficient Peruvian Guano in his vest pocket to cover the same amount of ground that a carload of stable manure would cover. As our farm at that time lay on a hill, he used to use it. It took me years and years, with plentiful use of stable manure, to get back that land where it would bear good crops again, that he raised splendid crops on with Peruvian Guano. He had not used anything else much but Peruvian Guano in his days. We use the commercial fertilizer. I carried that idea until the Connecticut Experiment Station set me at work on an acre with special fertilizers. I put on a fertilizer, a chemical, on one plot. On another plot there was absolutely nothing. Where there was absolutely nothing there was little more than nothing. Tried it year after year. I called the lot spoiled when I got through; but, to my surprise, where we put three kinds of complete fertilizers, we raised five good crops, had a fair crop of oats, and good stand of clover; and I never was so surprised in my life, and am, to-day, an advocate of commercial fertilizers, if somebody will furnish them.

Mr. Hoyt. As to the application of manure on top. That is all right. That acts as a mulch. But I should say the same as I would say if a man would put whisky on top of his head, and not in his throat — he would be better off for it.

Prof. Atwater. There is a great deal to be said on both sides of this question. Mr. Hinman and Mr. Hoyt have spoken of their experiments and experience with regard to chemicals versus barnyard manures in dry weather and all kinds of weather. Some of the gentlemen here well remember how, nearly twenty years ago, they started out on some series of experiments, in which they laid out their land in parallel strips, and used different kinds of chemicals, and used barnyard manure, and how they and I worked together, and they sent in their reports to me. Those experiments, as you have heard before, were distributed through a considerable

part of the United States. Now a large number of those bear testimony entirely in accordance with what Messrs. Hoyt and Hinman have just said. I was interested to see how many cases there were, when in dry seasons, the yield of crops, and, with the rest, the yield of potatoes was larger with the chemicals than with the farm manures. I was also interested to see in how many cases the farm manures, which the farmers themselves thought were on the whole better than the chemicals, were "beaten" by the chemicals, according to the farmers' reports. Nevertheless, I do not believe to-day that, on the whole, we have any right to say that either chemicals are superior, or barnyard manure, or horse manure is superior. Sometimes one, and sometimes another works best. There is, however, this to be considered, which the discussion has brought out, and that is, that the nitrogen, phosphoric acid, and potash in the barnyard manures are often slower in action than in the quick-acting fertilizers, but that they last longer oftentimes. Without going very much into the discussion of that subject, I want to say something more, which, I presume, to-day will seem to you as strange as the statements that chemists used to make 20 years ago about the chemicals, nitrogen, phosphoric acid, and potash. You thought us theorists. Well, we were. I want to bring some more theory. There is another kind of fertilizer about, that we are coming to hear of, and that is the microbe. We, in these discussions, the farmer and the chemist, always have a little reserve thought. We know we don't know the whole. Science, in its advance, is bringing out another idea on this subject. It is, that the plant needs not simply the nitrogen, phosphoric acid, and potash, and other ingredients of manures, but wants some help so that it may utilize a larger amount of material stored up in the soil and air, material which is essential for its growth; and we are learning that the plant is helped to get that material by these very minute organisms which we call microbes. It is coming to be commonly understood here to-day that plants do get nitrogen from the air,

though we did not believe it a few years ago, and we have lately learned that they get it by the microbe. We are learning also that it is the microbe that helps transform the organic matter of the manure and the organic matter of the roots of the plants in the soil and make it available so the plants can use it. Scientific research is going still farther and telling us that we must have the right kind of bacteria in the soil if the plants are going to thrive, and we are to get the best crops with our fertilizers. The time is already here when the right kinds of bacteria are available, or becoming so. We are already learning about bacteria for the ripening of cream, and how, if you have the right kind, you get gilt-edged butter; and if you don't, you get bad butter, and all that sort of thing. We are learning what kinds of bacteria help clover and other kinds of leguminous crops to get nitrogen from the air. A German, whose name has long been familiar to Americans, Prof. Nobbe, in Saxony, has gone so far as to get the peculiar forms of bacteria that are adapted to help different species of plants to get their nitrogen from the air, and separate them, just as you get different kinds of seed, and is reproducing them, cultivating them, and has got to the point where he has had put on the market the bacteria that are fitted for different legumes. Now, in connection with the experiments at Storrs Station, we are practicing on the inoculation of different leguminous plants, inoculating them with different bacteria. But this German has got ahead of us, and he has got the pure cultures, which are put on the market; a handful suffices for a very large amount of land. In this way we may get the fertilizing material, not the plant food, but the minute organisms which help the plant to get its food from natural sources, soil and air. I say that kind of material is being made available to the farmer, and sold at such prices that the cost amounts to very little. Dr. Jenkins tells me that he has already got some of that material from Germany, and I have been thinking of sending for some; and I presume that whoever attends the meeting in Danbury 20

years from now will be talking of the bacteria, different kinds of microbes fitted for different plants, as Mr. Hoyt has been discussing the use of fertilizers. I like to get up before you once in a while and call your attention to the progress we are making in these lines. It seems to me it is magnificent. [Applause.]

Mr. Hubbard. I have listened with great interest to Prof. Atwater's remarks in this matter, but I am a little bit troubled at the situation between us and the scientific men. Here we are. We have about caught up with where they were 20 years ago, and thought we were pretty even with them. Here he now discloses the fact that they are 20 years ahead of us still. We are not any nearer than we were then; but he holds out the hope to us that in the course of twenty years we shall get up to where they are now. What I want to know is, if he has any idea where he will be 20 years from now? What new scheme he will have then? [Applause.]

Gov. Coffin. Will Prof. Atwater answer?

Prof. Atwater. That remains for fate, and not this convention or men of science to decide. But if we chemists and other scientific men did not keep — I won't say 20 years ahead (Mr. Hubbard knows that is not what he meant), but if we were not keeping ahead in that kind of inquiry, so that once in a while we could come and tell you something of the changes, something which is new, and which you could study into, which you could verify in your experience and test whether it was true or false, and once in a while find it was true, what use would you have for us chemists?

Mr. Gold. I want to ask Prof. Atwater if he has not got a good deal of ore in sight, as the miners say, now, a good deal of ore in sight that is not fairly wrought out and put into the crucible?

Prof. Atwater. Mr. Gold asks a fair question; it is a profound question; it means a great deal. I hardly dare answer that question and tell you exactly what I think. If I did, I should say to you that 20 years ago, when you were so kind

as to listen to us and listen to me, and to the crude things that, as a young chemist, I used to say to you, that I saw some ore; I knew I did, and you believed there was some there; but the visible supply of ore, as Mr. Gold calls it, the prospect ahead for useful and inspiring discovery, and as we used to see it 20 years ago, compared with what is in sight, and what we think we see ahead to-day, is as the old-fashioned candle-light to gas-light, as lamp light to electric light. [Applause.] Why, the vistas that are opening before us grow larger and larger decade by decade, year by year, they are like starting from the center of the circle and going out to the circumference, and going further and further, and the further you go the longer the radius of the circle, the larger is the diameter, and the greater the area! There is that great beyond, illimitable space! And that is where we are in our scientific research.

Mr. Hoyt. Do you think it will make things any cheaper than they are now? I mean farming products.

Prof. Atwater. Yes, sir; I hope so. I hope it will make things cheaper; and I hope that the apples and other things Mr. Hoyt sells to me will continue to be cheaper, and I hope Mr. Hoyt will find the things he buys cheaper. I hope we shall keep on the next fifty years the way we have been doing the last fifty years. Now, that brings up the question, and as you throw down the glove I will take it up and meet you. Mr. Hoyt and I were talking about the hard times a little while ago, as we were to hear about it from Mr. Hubbard. We are both of us getting to be tolerably old men, especially myself. When talking about things when we were boys, in the dim and distant past, Mr. Gold can almost remember that time, and how we used to get up in the morning in mid-summer, haying time, before the sun did, and go about our farming work, and the sun had set long before our work had stopped! Then the folks of the farm got more for their produce in some ways, more per bushel or per ton, but they worked a great many more hours in a day, and more hours in the night, and they had much less of the amenities of life,

they had a harder time, and less comfort. Now then, with the progress, which makes many things cheaper, many products of the farm and factory cheaper, and makes it easier for us all to get them, and makes more to divide and distribute, notwithstanding there comes the difficulty of distribution sometimes, there is an increase in comfort, there is an increase in resources. We all know that. There is increased opportunity for us to get those things which are above and beyond the drudgery of plowing and of daily labor. There is opportunity for us to do as our fathers did not do, not simply to attend agricultural meetings, but to have books at home, to have things that belong to our aesthetic side of life more cultivated. Prices, I hope, will continue to go down. I hope we shall have apples cheaper, and more of them; and I hope we shall have good clothes cheaper, and more of them; and hope we shall continue to have books cheaper, and more of them; and music cheaper, and more of it. Think of it! Would it have been possible to take farm boys and girls a few years ago into an agricultural school, and then bring them here and give to us music like this? (referring to the orchestra) Things are getting cheaper, so we can afford it; and I hope they will continue to do so.

Dr. Jenkins. To turn from this review of the past and the glorious outlook of the future to the humble manure heap. It is humbling and profitable, perhaps, to do so. Now, I think Mr. Hoyt's position is this: not that stable manure, farm-yard manure, is a thing to be despised and thrown away, but it is to be used, used rationally, and made the most of all that is on the farm; that when that has been rationally cared for and used, then any further deficiency in the plant is to be made up by fertilizer chemicals, rather than purchases of stable manure. It seems to me that it is the only rational ground to take. As I understand Mr. Hoyt, he is far from saying that stable manure is useless on the farm, or that he would neglect it; only, having used that to the best advantage and made the most of it, then any further needs shall be met

from fertilizer purchase. The practical question in connection with that is, "What shall we do with our manure? What shall we do to make the most of our stable manure?" It seems to me a great deal more can be done than is at present to improve the quality of our stable manure. It has been shown that stable manure of some kinds contains over 82 per cent. of water; so that over 1,600 pounds of manure is water, a dead waste and no use. Now, that can to some extent be remedied by rational care of the manure heap, and by supplying a proper amount of litter to the cattle, so that the cattle themselves are kept clean and the quality of the manure improved. What we desire in stable manure is not only the nitrogen, phosphoric acid, and potash, but well-rotted soil humus, which will improve the chemical property of some of our soils. Some may have enough in them; on others it may be useless. But it should be our aim to secure the largest amount of humus possible. By paying a little attention to the matter of litter, to protect it from the outrageous waste so common, we shall not have proportionately so much water to haul on the fields. When that is done we shall be ready to consider the matter of fertilizers. It is proper to pay more attention to the production and preservation and storage of our stable manure. The word "trash," as used, I take to be a use of the word which is not so common with us as it is, perhaps, South. "Trash" does not necessarily mean a thing absolutely worthless, but refuse material, straw, leaves, and that sort of stuff, which, when properly rotted, makes excellent manure.

The discussion continued till 4:45. Closed with music, and recess taken until 7:30 P. M.

EVENING SESSION.

December 15, 1896.

The assembly was called to order by Vice-President Brown.

(Music by the orchestra.)

Mr. Brown. Our Secretary finds that he has quite an accumulation of queries in the box, and we will let him put those for our benefit, before we proceed with the program.

QUESTION BOX.

Mr. Gold. "Has any one grown the Sutton Beauty apple?"

Prof. Gulley. We have that at the college, doing very nicely. If there is any objection to it, it is from growing so tall that you have to climb to get the fruit. The apple is a very fine one, and keeps nicely. It is much better than the Baldwin, an apple, in other respects, very much like it. You can see a model in one of the cases, giving an idea of its looks. I had a very different one sent to me from Massachusetts this fall, under this name, but it was not a Sutton Beauty.

Mr. Hill. I have not fruited it, but have seen it grown in the vicinty of Worcester, Mass. It is a tall, rapid grower, and is a very free bearer, more so than the Baldwin, and more hardy. It is similar in outward appearance to the Baldwin, though I think the skin and flesh inclines to be more yellow and brighter red, and far better in quality. So far as I have seen and known of it in Massachusetts for a number of years, I should plant it in preference to the Baldwin for a commercial apple, and believe it is the best red apple in New England to-day.

Mr. Gold. "Are we to expect a larger crop of canker worms next year than we had last?" Where is the prophet on canker worms? Have our experiment stations any prognostication on that subject? They are here to answer all questions of this sort — provide for every emergency in farm experience.

Prof. Britton. I do not think it would be safe to make a prophesy. It was very abundant the past season; people

said it was more abundant than they had known it for 15 years. I do not think it will be any more abundant than it was the past season, although there is very little on which to base a prophesy.

Mr. Brown. Is the fact of its abundance this year any indication of its scarcity or abundance the succeeding year?

Prof. Britton. It is natural to suppose, being very abundant the past season, that it would also be abundant the next season, provided its natural enemies did not hold it in check. It is the history of all insects preyed upon, that when they are very abundant one season, that their natural enemies would also increase in abundance, because they had abundant food supply. If there was anything to prophesy in that regard, it would be that the canker worm would not be as troublesome next year.

Mr. Gold. "How to kill White Birch?" Where is the man who has had a contest with that and came out successful?

Rev. Mr. DePeu. Taking the contribution of one who is not a farmer, it may be of interest to know that a certain gentleman asked one of our farmers in Norfolk some years ago when to cut his White Birch, and he said he was going to let it grow up for timber.

Mr. ———. I have sawed them off, and killed almost the entire lot. I put the question in myself. I noticed where they sawed timber for the steam sawmills the trees never sprout; if they do, they do not live one year. I tried the experiment on White Birch, and killed them.

E. Manchester (Bristol). I have had some experience with White Birches, and by constantly cutting them every year, and feeding the pasture where they are very close, I have run them out.

Mr. Hubbard. Cut them and put sheep in the pasture, and that will destroy them.

Mr. Gold. "What is the best way to destroy cut worms?"

Dr. Jenkins. Last spring we tried a remedy that had been recommended to us for keeping out the cut worms from our

tobacco experiment. Took about 600 pounds of wheat bran and mixed with it a pound of Paris green, with enough water to hold together tolerably moist, and went over the field and dropped it at every step across the field, and the result was that many thousand cut worms were killed, and our tobacco got a start we never had before. This might be too expensive for general application.

Mr. Hale. On our tobacco farms in Glastonbury we used bran in the same way, sprinkled a little around each hill after the tobacco was set. Did not use any such quantity of bran. It was used with sweetened water, and it saved the tobacco.

Prof. Britton. I would like to add that some people place this in the field a day or two before setting the plants. In that way they get rid of the worms before they have a chance to attack the plants. Some report that they will attack the plants in preference to the preparation. If it is placed there a day or two before, after the ground is plowed, it is good. Also fresh clover is good; moisten that with Paris green, and that will answer the same purpose as the bran.

Mr. Gold. "What is the best variety of quinces?" Our master on that subject is not here to answer. Meech's Prolific is a very promising variety; and whether Mr. Hoyt has anything that is superior, or Mr. Platt, or Mr. Hale, or any of these men, I do not know.

Mr. Hale. There is nothing better than the old Orange quince, that I know of.

Mr. Gold. The old Pear quince is a little sounder, less liable to crack, and keeps longer, and has some advantages.

Mr. Gold. "What is the best remedy for diarrhea or scours in young calves?" Well, that is a long veterinary question that can hardly be fully discussed here. It often arises from contagious disease prevailing in the stable and barns, and remedies have little avail in such a condition of things. If it is an occasional case, that is to be prescribed for and attended to according to the particular case. But if you have got the contagious disease in the stable or barn where

you keep your calves, why, I have sometimes thought, you had better burn it up, if it did not burn something else, rather than to tolerate it on your premises. Its disinfection is a long and tedious process, and you don't know when you have got rid of it.

Mr. Gold. "How can we catch ground moles?"

Mr. ———. What do you want to catch them for?

Mr. Gold. That is what I was going to ask. There are some people who make a great complaint about the little hillocks they make. We know what that little fellow is about. He is going under the turf and picking up the grub worms, and he never disturbs a root or plant if he can help it. If it happens to stand in his way, he does not turn out to avoid it, but, otherwise, his work is harmless, and he is burrowing there beneath the soil, working the best he knows how for our benefit, and I rather feel sorry when I find the cats have caught one.

Mr. ———. Perhaps there are not many gentlemen who know that that animal has to have more than one-third of its weight of worms to live. He will not touch anything else as long as he has as much as he wants in that way. I spent about six or eight weeks one summer with several, trying to feed them as much as they wanted, and that was the result. They are not there to eat anything else but insects, if they can get them. They will eat other things, though. They eat peas, peach pits, and I think they did eat a little sweet corn. Those were the only things I could make them eat without starving to death. Their damage is done more by traveling, but they are there to eat insects.

Mr. ———. There is another animal that possesses much malice. It is the mouse. And what he is about is eating up your wife's tulip bulbs, and that sort of thing. He does not take much animal food, but is fond of bulbs, and prefers those imported. He will tackle new things you have from Holland and Japan. That bobtailed mouse, that is posing as a mole, is the greatest pest with us in the vicinity of our

flower beds. I think I have found what will wear him out. I made a caustic poisonous preparation, and as it stung his toes he would lick his toes, and he was gone.

Mr. Gold. "What experiments have been tried to prevent potato scab?"

Dr. Jenkins. I do not think there has been any treatment suggested which will prevent scab where a large quantity of stable manure is used.

Mr. Gold. I will put the question back into the box, with the chance of its being called up again, and we will invite you to reply another time.

Mr. Brown. Ladies and gentlemen, I now have the pleasure of introducing to you Dr. DePeu, who will speak to you on the subject of "Rural Cemeteries."

RURAL CEMETERIES.

By Rev. John DePeu, Norfolk, Conn.

Mr. President, ladies, and gentlemen: I appreciate the honor of the invitation that came to me to speak before this honorable body, when my revered friend, Mr. Gold, first wrote to me. Since being here I have regarded it with still more of gratitude and appreciation. I have been looking around this body and contrasting the figures I see before me with the popular illustration of the American farmer, — the man unkempt, unwashed, largely unclothed, with overalls half tucked into his cowhide boots, his suspenders the most prominent part of his costume, represented not thus at his work on the farm only, but in all his social intercourse. But, gentlemen, this is no new thing to me, for I have the honor of being one of the back-country parsons, as my parish is up in one of those hill-towns that we hear so much about.

I have wondered a little that so many came out this evening for this discussion, which can hardly be called a "live topic." I beg you, do not blame me for the deadness or dreariness of the subject, but blame your honorable officers who have appointed me.

I have here on my paper notes, first of all, for quite an

extended introduction to the subject, a discussion of the pyramids, a dissertation on the catacombs, a contrasting of the Indian Mounds and Westminster Abbey, an excursus on the graves of unknown races found in Egypt, and those under the Pincian Hill in Rome, antedating the foundation of the city. The notes are here for this, and if I spare you the recital, you should lay it especially to my credit, and if you grow weary, comfort yourselves with the thought of how much worse off you might have been.

I want to speak in a very simple way to-night, and it will be, most of it, an old story. The most that can be said in favor of any so-called lecture on this subject is, that it may bring your thoughts together, and bring the whole matter into clearer light and higher relief. It is a subject that you and I will, some day, be directly interested in, one that I have to be interested in frequently. Counting over the number of deaths in a ten-years pastorate not long ago, I found that in my own little town up in the hills, death had entered in the ten years over 100 of our protestant households, and had come into many of them once, nor twice alone, but three, four, five, and six times. And so this subject is one that should lie close to our hearts. Moreover, as I shall have occasion to remark further on, it is in your power to do much in your respective towns toward bringing about a better ordering of the cemeteries, and a more proper care for them, as those who are gathered at such a meeting as this are the ones whose influence will be most felt in the community in respect to every improvement and reform.

The first thing in order is to define the term, "Rural Cemeteries." It is written in the book of the chronicles of the cemetery superintendents of the nation, that the first "rural cemetery" was Mount Auburn, in Boston, which was laid out, if my memory serves me right, in the year 1831. According to our interpretation of the term, rural cemeteries were established in New England, in Connecticut, at least, long before that time. The first cemetery in my own town was a rural cemetery, according to what is now the accepted definition of the term, which is, a burying-ground removed from a church edifice; one in the country, where its surroundings are not ecclesiastical, but rural. That should be our understanding of it.

The matter of ownership brings us first face to face with

the private burying-grounds. They rise up before the minds of all — that little spot off in the corner of the meadow, where there is now only the remnant of an old picket fence, and one or two trees spreading out their shade over the low headstones, or where there is now, perchance only a wild tangle of brush and briars about that spot where long ago the dead of one family were laid away. Happily, these private burying-grounds are a thing of the past, in most cases. A few are still used by families who have kept up the old farms. That is one advantage, I believe, your honorable Secretary boasts of, in that his farm has never passed by deed from its first settlement; but in most of our communities these farms have gone from hand to hand, strangers have come in — Pharaohs "who knew not Joseph," many of them speaking in Hibernian or Canadian accents, caring little for our sacred dead, and finding it difficult to work up that enthusiasm which was manifested by the general in the Pirates of Penzance when "he wept over the tombs of the ancestors whom he had purchased with the estate."

The second class of grounds was those held by ecclesiastical societies. These, of course, were first of all churchyard burying-grounds, continuing a custom that was imported from the old country, where the consecrated ground was most naturally ground attached to the church; and yet this method of holding has been carried out in modern times to other grounds, so that beginning, perhaps most illustriously, with Trinity cemetery, on Washington Heights, New York, it has been extended until many church corporations no longer bury their dead beside their own places of worship. One of the most prominent burying-grounds near New York, is that held by St. Patrick's Cathedral, at Newtown, Long Island, and along on Long Island and in New Jersey are many others of these ecclesiastical burying-grounds. The laws of our State make special provision for such holding; but more common than this is that by cemetery associations or by towns.

The cemetery association holding has decided advantages in certain ways. It has this advantage, that it is, as a rule, a business enterprise, and to be made successful as a business enterprise the cemetery must be properly laid out, must be attractively located, must be suitably cared for, all of which things are most desirable; and the cemeteries that are most

prominent in your thought as the best types to-day are mostly those held in this way.

Is there any disadvantage in this? It seems to me, gentlemen, that there is a decided objection to it. I have the feeling that there are two points when we all have equal rights in the State, and when the State has equal responsibilities towards us, that the State should guard the childhood, and that in death the rich and poor should be one together; that there should not be a heavy tax laid upon those who would lay away their dead in a decent place, and not have them ignominiously branded by the burial in the Potter's field; and that, as I shall hope to consider further on, there should be a community of interest, which will be fostered by the common burying-ground, where we all go together to weep in the common sorrow and to rejoice in the common hope.

We come, then, to what I feel is the ideal holding, and that is the town proprietorship of all the burying-grounds. This, of course, in Connecticut, was the rule even when there was apparently the ecclesiastical holding of the burying-grounds in the days when the ecclesiastical society was simply the town in its town meeting, and when the ecclesiastical property was held and controlled by the town. This may have disadvantages in some cases; but it has the advantages that I have spoken of: it brings us all together; it thus helps us to recognize the common humanity; it takes away one of the sorrows of the death-bed; and it will help to advance that to which I am looking forward as an ideal in the burying-ground. The disadvantage is patent to all. It is hard to keep our communities toned up to such a degree of aesthetic sense as is worthy of the simple term of decency. If you journey about our New England towns the saddest thing you see is, not that old hole in the ground, with the crumbling pile of stone in the center, where once the family gathered about the hearthstone, and that wild tangle of lilacs and vines running to waste, which has been well dwelt upon in the "Deserted Farms," but the saddest thing, because the most shameful thing, in our communities, is those old burying-grounds that you find here and there, where all the stones left standing are staggering to and fro like a tipsy man, where the fences have rotted down, and the cattle have easy ingress, and where there is a tangle of briars and bushes, and, even as in cases of which I have been told during the last few hours, a young forest has sprung

up among the old graves. The old burying-grounds have often been lost to sight, until, in one case recently, a long-forgotten ground was found in clearing away the woods to make a reservoir for a town water-supply. And here and there they are scattered about in the woodlands and fields, lost to memory, and neglected by man, simply because the communities have not kept up a decent remembrance of their dead.

And yet, in the laws of our State, it is provided that if twenty of the voters of any town will so petition the selectmen, those selectmen shall put in order, properly fence, mow, and keep in order any neglected burying-ground in the town, at an expense not exceeding one hundred dollars. Now, if there are these neglected grounds, and if the selectmen of the town are not interested in restoring them to a decent condition, will you remember — and here is good work for the ladies — that it is only necessary to get twenty voters to be of decent mind to have this matter corrected.

Then as to the matter of location. The early burying-grounds were mostly in the neighborhood of churches. That brought them into the very center of village life. I do not know how generally that is true throughout Connecticut. In my own town the first burying-ground there was not contiguous to the church, but somewhat removed, and is still in use. But in the cities it was common to bury about the church building. What is the result? You know the disgraceful tale about the old burying-ground about the Center Church of Hartford; how buildings were allowed to encroach upon that ground; how the remains of the founders of this Commonwealth were taken out and thrown about with gross indignities. Some were lost, and some were reburied. You know how the burying-ground about the Center Church in New Haven has been made a common field, the stones removed, and the old graves leveled. Why could not these grounds be kept? Have the dead no rights among us that we are bound to respect? But the first fault was in the locating of the burying-place upon land that would soon become of such value as to over-tempt greedy men who would desire to possess themselves of income from the consecrated grounds.

The location, then, ought to be so planned as to be outside of the range of the land that is likely to become in the visible future of such value as to tempt men to desecrate the grounds. It should also be accessible. And that has been the reason we have had so many small district burying-grounds in all

our country places. This accounted, of course, for the making of the little family plots in the early days, when the neighbors were out of reach and it was impossible to carry the dead long distances in the stormy winter weather. There are provisions of law in regard to location of cemeteries, which should not be within half a mile of a reservoir of public water-supply, or within 600 feet of any ice pond, without special permission of the courts. You may say, "Our burying-grounds are all of them located, and any discussion of such location is in vain here." I hope not. I can site cases where there ought to be immediate interdict on any further burying, where the ground should be preserved as well as possible, with all which is there. Another case where the grounds are becoming cramped, and it will be necessary in the near future to find new grounds; and, with the increase of population, this may be necessary in many communities.

Certain suggestions may be in order here, and I shall speak in a very practical way, out of my own observation. I have put down as the first note, "avoid steep hills." It may seem to you that this is unnecessary caution, but I have seen a cemetery upon a hillside, that boys would delight in because of the steepness of the ascent, but which no man beyond middle life ought to try to climb. I have seen four men scrambling up that hillside with a heavy casket, where I, at the head of the procession, found it difficult to keep my own footing, and half way up that slope, because of its steepness, one of the bearers, losing his footing and bringing down the end of the casket with a crash upon the ground. And the whole burying-ground was laid out on that steep hillside, gullied on one side by the road, so that it was impossible to make any proper approach to it. This is not simply one cemetery within the year. I have been at another funeral, in another ground, where, the burying being in winter, the ground was slippery, and they cleaned the paths as well as they could, but the men went up that slope with a heavy casket, slipping backward at every step.

There is another extreme which should be avoided. I heard an account given recently by a friend of mine who sat in a church during a funeral service. It was raining heavily, and all the time during the service, came, at short intervals, swash, swash, swash! They were bailing out the grave within hearing of the church! More than one friend has told me of seeing caskets lowered into the water, because the graveyards

were located in such marshy soil that the graves could not be kept dry! Why the burying-places were made in such spots I do not know. Men who know about the tillage of the soil should know better about these things; but these things occur. Think of the wrenching of a mother's or widow's heart, when that casket goes down into a wash of vile water, instead of being decently laid in the cleanly earth.

But there is one other location to be avoided, and that is, bleak, exposed places. And that is a common indictment, so far as I know of burying-grounds. It seems as if the fathers, when they put the churches on the hilltops, sought out the second bleakest place in town, and made a burying-ground there. It is due to this that so often one funeral leads to another funeral. More deaths are occurring in the bleak winter weather than the mild weather of summer, and you have that to count on. If there cannot be a proper screen made (as I hope to indicate later) there ought to be a move made from some of the old grounds, for the sake of the living.

Sand-hills also I have noted, having in mind one burying-ground that is a sand-hill, where there can be no decent grass grown. I suppose it was thought to insure good drainage, or else it was waste land, good for nothing else. I have in mind a burying-ground in Savannah, which I will allude to later, which some of you may remember, in that dreary waste where no turf can be raised.

Avoid cramped quarters. Let it be seen to, first of all, that there is plenty of room, for there is one farm that is going to grow. Everything else in your community may stagnate, but your burying-ground is going to grow from generation to generation, so that the land that seems beyond all possibility of need for generations to come is exhausted oftentimes within a single generation; and this, too, I shall refer to later.

Now we come to laying out. As you go up and down the country you will see everywhere old-fashioned burying-grounds which are nothing but burying-grounds. The grounds are laid out generally four-square; the lots are rectangles; the roads are often inconvenient by reason of the exactness of the geometrical figures; and it is simply a place packed full of graves and atrocities in marble and granite. It is a place that is simply terrible, from any point of view. But there is a modern development of the cemetery, which makes it a beautiful piece of landscape gardening. And this

might be yet carried out in many of our grounds as they stand, or as additions are made to them.

Now, in regard to the layout, of course the general principles that you need to observe are those that govern all landscape gardening. There is no hard and fast rule as to how the ground should be laid out, for there are no two places alike. Study the situation and try to make your plans fit the location.

As to the details. Fortunately, we have gotten rid of the old idea that the dead must all have their heels toward the east, so that they may rise up facing the Lord at His coming without turning around. Now we put them either way, and believe they will find the Lord's face when He comes. So we are able to lay out grounds in properly diversified fashion.

First, as to the roads, a live subject to us now in Connecticut. The roads in our burying-grounds ought to be carefully laid out, carefully shaped, and then grassed. There is hardly a rural burying-ground in which you cannot have all the roads grassed. There may be some larger ones in which part of the roads will have to be treated otherwise.

Another thing. I put this from the point of view of one who has been very familiar with the difficulties attending funerals. Can you tell me why so many of our burying-grounds were laid out in such a way that you cannot get all the carriages in near the grave, or when you have gotten them in there you cannot get them out without a long tangle and confusion in the turning places? Why not lay out the roads with a view to gaining easy access to all lots, and then returning by a parallel road, so that there will be no confusion of the carriages going in and coming out? That is a simple suggestion that is eminently practical. In many of our small grounds much would be gained by putting in a second gate, so that we could have entrance at one gate and exit at another. Curved lines should rule in the laying out of these roads, avoiding the long straight lines, which are monotonous and unpleasing. One of the most beautiful cemeteries in this country is the one at Lexington, Ky. This has this double advantage. The roads are laid out on curves. Every lot in the cemetery, however, is rectangular. You see what is the result of that. You bring rectangular lots contiguous to curved roads and there are angular spaces that are not appropriated.

The advantage of this is that there is a considerable amount of space in the cemetery which cannot be filled up with graves and tombstones, and can be utilized for the development of the beauty of the grounds. That I will come back to later.

As to trees. I have spoken of the exposure of many of the burial-grounds. What is to prevent our treating those bleak places as you treat similar bleak places on your farms? You put up wind-breaks to protect your houses. You plant a row of evergreen trees to protect farm buildings. Why not, on the windy sides of burying-grounds, in every case of bleak exposures, put in at once wind-breaks of evergreen trees for future protection? It will save some lives before two generations are gone. But trees ought to be put in burying-grounds more than they are, to give a different character to the ground. You take any of these little burying-grounds that are so desolate when there is simply a lot of tombstones, and you put in two or three trees, and you change the whole character of the place. But you ought to avoid some things. I should say avoid trees that have wide, spreading roots, for you know of the difficulties that arise when there is a mass of roots spread very widely over the ground where the graves are later to be dug. Take the trees that are more beautiful of form and color. Put in trees like Wier's Cut-Leaf Maple, and the cut-leafed Birch; put in Purple Beach, and Purple Maple, and some Oaks, and those trees that have beauty in themselves, where a single one of them standing alone will beautify the surrounding place.

But depend more on shrubbery. Let us have more shrubbery in the burying-grounds. This can be introduced in old grounds. We are doing it about our houses, and making them more beautiful.

One thing I should say, do not plant shrubs at all on graves, or immediately contiguous to graves. I do not know how you feel about it, but I do not like the idea of even flowers growing on a grave. It suggests a little too much their feeding on the bodies that lie beneath. It is a beautiful conception of Mrs. Browning's in "My Kate," as she says:

> "It always was so with her, see what you have.
> She has made the grass greener even here with her grave."

That may do, but in my own grandfather's experience many years ago, one of the disadvantages of putting shrubbery by graves was illustrated. Two of his little children were laid

in one of the old grounds near the old home, and after some years the bodies were disinterred and carried to another place. There was a rose-bush which had been planted — a white rose, a beautiful emblem — upon the grave of the little girl. But when they took up the bones, all that was left, they found the tap-root of that rose-bush had gone down into the grave, with that wonderful cunning roots have, and found the body, and entered the spinal column at the base of the brain, and gone all the way through the spinal column. In our family we never put shrubbery on graves after that. Let the flowers be in the burying-ground, and more than they are, but let them be in these unoccupied spaces, which I have advised you to secure in the laying out of the grounds, and in some of those forms of artistic bedding with which we are learning now to beautify our lawns.

Following out these general suggestions the whole cemetery may be laid out with exceeding beauty. It may come to be like one which, I suppose, must be very beautiful, at Woodbury, Conn., a cemetery I never have seen, but heard of often, through a good old lady, who had been living many years in fear of death, but at last, for two years, was filled with one great desire, saying often that she wanted to lie in that beautiful cemetery over in Woodbury. She reminded me of that puff which was given to a certain undertaker, who paid liberally for his advertisements, and got the editorial notice that "he was such a master of his business that it was a pleasure to be buried by him."

Now, as to the lot. You know what the modern rules are as to the so-called lawn-plan of cemetery treatment. In the first place, no enclosures, no hedges, no fences, and in the better conducted cemeteries, no copings are allowed about the lots. One wide, open expanse is thus secured, which can be treated in a broad plan, giving a park-like effect. It is amazing to what extremes people will go to enclose their own particular lots and individual graves. I have referred to that forlorn cemetery at Savannah. They tried down there to enclose their lots as well as they could, and brick was a common material used. Those who were too poor to purchase brick had gone on the shore and gathered clam shells and set them all around the lot, and outlined the individual graves with them. But one man, with exceeding ingenuity, not satisfied with clam-shells, wanting something a little more architectural,

perhaps more symbolic, had put about his lot and the individual graves rows of empty beer bottles, set on end and half buried in the ground! There is just one proper way of marking the lots, that is by a corner-stone, set flush with the grass.

Then we need a new order of things in regard to headstones and monuments. In the better conducted cemeteries there is a limit of height allowed for headstones. There is also a minimum of thickness, to get a proper proportion of height and thickness; and there is a rule requiring suitable foundation to be put under the stones and under the monuments, so that they shall not sink into the ground, or fall over sideways or edgeways. When the new order is universal there will not be so many horrible accumulations of the work of the stone mason. I saw not long ago one small lot in which one family was buried. In it was a large obelisk of gray granite, which was erected with an apparent intention that no family monument in the town should ever surpass it. Close beside that monument, which was enough for several families, was a huge red-granite sarcophagus. Just back of that sarcophagus, and cornerwise from the obelisk, was an ornate stone, in imitation of a Gothic portal. Cornerwise from that was an old-fashioned table monument, and then various headstones of different sizes and descriptions of old slate and marble, and old brownstone, were largely filling up the rest of the lot. There is in my old home another lot, on which the collection is more wonderful, as it introduced two figure pieces, almost in contact with each other. What is the effect? You think you are at a stone-cutter's establishment, viewing the specimens displayed in front of his shop. There is no beauty in such a display, because no propriety and no harmony.

They have adopted, at Lexington, a plan by which they secured a better condition. They have made all the lots of equal value, and they have secured thus a distribution of the finer monuments over all the grounds, and people are coming to recognize that the only excuse for a monument on any family lot is its beauty; that it is not to be set up to show how rich the family were, unless it has some intrinsic beauty in itself.

I want to advise another thing, and that is that all grounds should be cultivated with flat graves, and that is one thing I wish to urge most. Have no hilling. Do not try to show just how old a child was by putting two or three inches more or less of length on the grave, but have a perfectly flat green

sward, smooth over the grave. But in order that there may be no mistake in regard to the location of graves, have them all marked with suitable stones as soon as dug and occupied.

Now, I would suggest this, that every one of our towns, where the town owns the cemetery, or every cemetery association, should purchase a dozen, or 25, or 50, as you will, of those small markers, such as are used in our national cemeteries. Wherever a body is buried, mark the head of the grave with a marker. Then if the family later wish to put a headstone there, that marker can be taken up and the headstone put in its place, and the marker will do just as well for another place. If, however, there are those who are willing to simply letter that marker, and have no unseemly and obtrusive headstone by the grave, marring the beauty of the ground, so much the better. And this use of markers I strongly advise, even without the flat cultivation, which makes it more necessary, for I doubt not many of you can remember times when the whole burial service has been delayed, while there has been a discussion among those present as to which way the bodies are laid in the lot. One man says, "They are laid this way," and another says "They are laid that way," and finally they call upon the widow to settle the question. The marking I advise will settle all such confusion.

There should also be a diagram kept of every burying-ground. There are books prepared for this, which you can obtain if you wish. But any man can make one, and have every grave indicated, with its exact location in the lot, and who is buried in the grave, with full record. And so you may avoid the confusion that sometimes arises.

Now, what have you? You have gained a park. It is not simply a burying-ground, but a place of beauty, and may be a joy forever. You have gained a beautiful park, large or small. Now let proper attention be given to its care. All lots should be cared for alike. The towns, where the town owns the grounds, should care for the lots. But there are other provisions which have been made for this in some cases. In my own town there is a small fee charged for the assignment of the lot, and that money goes into a fund for the care of the grounds. In my town there have been certain bequests made providing endowments for this care of the burying-ground, and it is an exceedingly good object for men to give to, in amounts large or small. The donors themselves

may reap the advantages of it in times to come. This care should be given to keep the grass, flowers, and shrubbery, to clean and straighten the stones, and preserve the whole in thorough order.

I was interested and relieved, in studying through Clifton Johnson's illustrations of Ian Maclaren's books, to see in the photographs of the Scotch burying-grounds, that the stones there had the same careening appearance that many of them do in our own grounds. I had thought myself it was a peculiarly American sin to neglect these grounds, but it is not. It is found on the other side of the water.

Now, as to these grounds thus provided and kept. What is the use of laying out anything of this kind as a park? First of all, because it may bring, as I suggested at the outset, a comfort in the presence of death. There is nothing that is comforting or in any way suggestive of hope in going to the old burying-grounds. But there may be a suggestion of hope, or, at least, a relief to the mind, in visiting grounds that have in themselves a beauty that will win the soul to some thought of the goodness of the Creator, and of the beauty that is in all of His designs; and thus we may gain a power that shall influence through a whole community.

If any of you have been to Bethlehem, Pa., you remember the feeling among the old Moravians there in regard to their burying-grounds. The burying-ground there is a public park. That is what I would have all the burying-grounds be, a gathering place, where the families of all generations might meet. On a summer afternoon, if you go into that Bethlehem burying-ground, you find the mothers are there with their work, chatting together, while the children are playing about among the headstones, learning there the family and town history, and learning that there is no wide remove in the spirit beside those who are for the time so close together, dust to dust on the earth or under the earth.

And beside this, we shall gain from such grounds as I have described a refining influence on the communities. I remember hearing with interest from Mr. B. G. Northrup of his coming into our town years ago, and the impression that was made upon him as he came into the town by seeing the profusion of flowers in all the dooryards, and of how he learned by inquiry that it all emanated from one garden, where one wise woman, loving beauty, and putting beauty in her own grounds, had led to beautifying all grounds.

If you make the cemeteries beautiful, people may catch ideas from it and beautify all their places. Have there your landscape garden; make it a model place, on which the whole layout of the town can be patterned. Do not think it must be a large place in order to accomplish this, for I remember with great delight a little back dooryard in old Plymouth, England. I don't know the size of it. As I went through it, it seemed to be 100 acres in extent. I suppose it was about 50x100 feet; but you did not see any fences, and the shrubbery was so arranged, with a little path running off this way or that, and seeming to run on endlessly through the shrubbery; though, if you knew the place, you knew that pretty soon it must come to an end between the shrubbery and fence; and the whole place was so developed that there was a suggestion of unlimited room beyond, and of beauty close at hand. You can take the smallest burying-ground, and if you apply any art to it you can develop all the ideas and win all these ends within it.

There are other things I wanted to speak of, but the time has gone beyond what I allowed myself, yet there are some suggestions of avoiding accidents, such as I have seen, of men falling into graves for lack of planking at the sides, of the use of evergreen over the edges of the grave, etc., but one thing I want to call attention to, and that is, the use of tents.

I have been talking with our funeral director at home for several years in regard to getting a tent for shelter for our ground, but we have found recently that we are only inventors at the same time with others. They are using two forms of tent in different places. In Mount Auburn, in Boston, they use the large tent of usual form, placed over the grave. They have two sizes; one where the carriage drives up by the side of the tent, the casket is brought in, and the friends come in under the tent and have shelter during the burial, avoiding dangerous exposure. A larger tent is being made, so large as to accommodate 150 people, in which the carriages will drive through the length of the tent and the friends will get out under shelter. But they are using at Woodlawn a tent, quite inexpensive, which ought not to cost more than $15, or perhaps less. It has three sides and a roof. It has a 14-foot opening in front, 8 feet 9 inches high. The walls draw together as they come back, 7 feet deep. The roof slopes down from 8 feet 9 inches to 6 feet 9 inches. The tent is set up with corner poles and gas-pipe connecting them. A tent of this

form ought to be provided for every one of our Connecticut burying-grounds, to guard against exposures in severe weather. This can be set just at the side of the grave, at the corner of the grave most properly, and give the protection that will be needed during a stormy time.

Your patience has been exemplary; but if this talk helps in any way toward bringing about any more of beauty in our burying-grounds, or any better care for them, I shall feel that it has been worth, not all it has cost me, but even what it has cost you.

Mr. Brown. I have no doubt that the very suggestive lecture which Dr. DePeu has given will provoke inquiry, and perhaps opposition; but whether it be inquiry or opposition from any one, we should all be glad to hear from anybody who has anything to say in regard to any suggestion which this lecture has made to you.

Mr. D. H. Van Hoosear (Wilton). I have been very much interested in hearing the lecture. It has been somewhat of a hobby of mine for a number of years, and many of his suggestions are fine. I would say, adopt them. He will excuse me if I should not agree with him in all respects. And as his lecture will go so far abroad, I am afraid he may make some little mistake in suggesting that we plant trees in our cemeteries. Of course, it would beautify the cemetery, perhaps, but I would say, do not have a tree or shrub that will grow over four feet tall; and all associations should make that a rule. We are having a great deal of trouble in our cemeteries, especially the rural and old ones, with the pine trees planted there, very pretty when planted, but they have grown now so that they are 30 or 40 feet high, surrounded completely by headstones, almost impossible to remove them, the ground is filled with roots, so it is almost impossible to have another burial.

I want to talk upon the law he has given you, that our State says if we apply formally to the selectmen that they shall see that old burying-ground is put in order. I have had some experience with it. I was very glad when I saw the law en-

acted; but it is not a success; and I would like to bring it before the convention in some way, so that we may at our next legislature have a penalty attached to that law. A law without a penalty is no good. We had an old cemetery in the town where I live, and it was a disgrace to the town. It was one of those that surround the old church. It had grown up with sumachs and everything obnoxious. I proposed to have that cleaned up; was ashamed of it. It was adopted by the town, and deeded to the town, so it is the town's cemetery. I have seen in that old cemetery two yoke of oxen yoked up in it, tramping around and feeding, with plenty of horses. That is enough to make anybody crazy when they go by to see such a thing as that. In the time of the blizzard there was a train of oxen left the main road and went through the cemetery, breaking down stones. They had a sled and men were on the sled. Nobody said anything. I had a petition signed and passed it to the selectmen. They did not pay any attention to the petition. They did not fix the cemetery at all; they never fixed it. I then went about for a subscription, and got what I could, and gave notice in the paper that we would all meet on a certain day and clean up that old cemetery. There were twenty came there and worked hard all day, and cleaned it up very nicely. That was three years ago, and nothing has been done since, except I had it inserted in one of the calls of the town meeting that we should expend $50 in fixing up the fence and in laying or replacing a piece of the fence that had been taken away by a man who wanted it to complete his cellar for his barn, and had never replaced it, leaving an open gap-way, so it was 20 or 25 feet flat to the ground. We succeeded in getting the fifty dollars, but the town men did not look very well; they think it is hard. We got it all fenced nicely, and got the gates put up in pretty good shape.

Now, I want a penalty to the law, and then when we send in our petition, if there is a $25 penalty, the selectmen will see that it is done, that it is proper and should be done.

About the selection of places for these cemeteries. It has

been handled very nicely. The low places he speaks of should be avoided, and also the very steep hilly places. I have seen a coffin lowered, as he speaks of, in a low place, where the grave was filled with water, on which they had to put stone to make it sink; and that was obnoxious to every one present, and those that were there will ever after remember it.

Rev. Mr. DePeu. I put in my pocket as I came from home this photograph. As to the matter of trees, no tree should be planted unless it is to have plenty of root-room. This is a picture of a tree (referring to the photograph) which has grown about an old tombstone near the center of the burying-ground at Norfolk. The stone bears date of 1821. This elm tree has so grown about the stone as to hide part of the inscription, and it has grown partly about the stone on the other side. A man and his wife were buried in those two graves, and they are united now with this elm tree.

Mr. Hale. I have been particularly interested in the presentation of the subject by our friend, and know from the way the rural cemeteries have been left to their own destruction in our rural towns that it is certainly time that the people of the State took some thought on the matter, not only for the better care and maintenance of those already established, but broader and more thoughtful plans for the future. And I think the speaker here has opened up the subject in a way that should interest us all, and has given us some hints as to laying out. To make it as beautiful and attractive a place at all times as we can is certainly our duty. It is our duty especially in laying out a new cemetery to see that ample ground is provided, looking a long ways in the future, and selecting ground that can be enlarged and that will not be encroached upon by any living inhabitant, or be seriously interfered with. It happens that within ten days I was in that beautiful cemetery at Lexington, Ky., he has spoken of, and was particularly interested in the laying out of those grounds. I do agree with you that there should be ample drives and an abundance of them in all directions; that the lots should be so arranged

that all of the grounds, or nearly all, shall be occupied; that there shall be planting of trees and shrubbery, that it shall be made a beautiful resting place. I cannot agree with Mr. De-Peu in objecting to flowers and shrubs growing upon the graves. Bless you! I think, as I go by the old cemetery near home, where just outside the fence there grows an elm, and a little over the fence lie the bones of my ancestors, I believe they are up in that tree living, and it is a pleasure to me. And the beautiful roses blooming on my friend's grave! I don't object to that at all. So of all my dear friends of this Agricultural Association, if after they are gone, if it shall be my misfortune to live longer than they do, if I should know an old elm or oak was growing over their graves, I believe I should go oftener to their resting place to have sweet communion.

Mr. Hoyt. I was wondering when Mr. DePeu spoke of this Lexington cemetery, if they thought to go to Ashton to visit the grave of that great statesman, Henry Clay.

Dr. Jenkins. While very much pleased with all said, I was especially attracted by the proposed provision for the comfort of those who visited the grave at the time of the funeral, and I am very glad that point has come up, for it seems to me that such a time is one of terrible exposure, particularly to the friends of the deceased, weakened with watching, anxiety, care, and grief; they are exposed to innumerable dangers; and I think most of us know of cases of fatal illness contracted at such a time. I have never seen any such improvement for a sheltered grave, but I think it is a thing that ought to be considered seriously in that regard. It is a cold bleak spot. People feel it necessary to uncover their heads, and they are in the utmost danger of contracting illness. A funeral in all its details, it seems to me, is a most horrible thing as ordinarily conducted. I trust that sometime having the remains in the presence of those attending the funeral will be prohibited. I consider it a hideous thing.

Prof. Britton. I have seen cemeteries neglected and grown

up with bushes, and I have seen them more often bleak and bare, with scarcely a shrub or tree within sight of them. Now, there is no reason why they cannot be made beautiful. It is true, many of our old cemeteries are small, and to plant trees in them would be to over-crowd them somewhat; yet, if there is plenty of room, I would have trees, but not scattering them about. Plant them in rows, or scatter them at equal distances apart over the cemetery. They can be given plenty of room placed in artistic groups, making it a spot of beauty. I would not use a fence of wood to decay, or iron to rust, in a rural cemetery. If these are kept painted and looking the best they can, they are most usually hideous and not artistic. Where there is a hedge about the cemetery I would let it remain, but I would not shear it into any formal shape. If there is a stone wall, it is, perhaps, as good as anything, for our rural cemeteries, but there is no reason why it should not be covered with beautiful Japanese Ivy, and relieve it from the barrenness and bleakness it usually presents. Perhaps I should not agree with the speaker in regard to introducing Purple-leaf Beech and colored foliage into the ordinary rural cemetery. This is apt to be done improperly, unless done by a master of the art. In our small cemeteries there are probably no better trees or shrubs to be used than some of our natives, which we can find anywhere on the hills. I am glad that the old-fashioned, ghostly white tombstones have passed away, and that the low blocks of granite and some other kind of stone are used instead. And in some of the Chicago cemeteries the matter of stones is all placed in the hands of a committee, and nothing which does not conform to the general design is allowed to be used. The graves are all leveled, so it can be mowed like a lawn. The lawn-mower will run over the stones marking the corners. A very good idea for cemeteries of larger towns and cities is what is practiced in Mount Auburn, at Boston, which the speaker alluded to as established in 1831. Early in the history of this cemetery, the designing and plant-

ing were placed in the hands of the Mass. Horticultural Society, a society to which many of the cultured and refined people of Boston, including landscape gardeners, belonged, and nothing is allowed to be planted in the cemetery, except something they can commend. While this could not be carried out in rural cemeteries as it could be in the larger towns and villages to the same extent, yet, in beautifying the rural cemeteries, a design should be made by someone competent. There is usually a man in each town, or at least in each county, who could suggest some artistic design, which would be inexpensive, to make the place beautiful. I would rather see it grown up to bushes than to see it bare, and yet I do not like to see anything of that kind. Where the bushes are allowed to grow at random, the grass to grow and never cut, it gives it a character of struggle, in the first place, and decay. This should not be experienced in a cemetery. Neither do I think it should be made a sorrowful place. Weeping Willows are usually planted in cemeteries because people go there to weep — supposed to be symbolic. In my opinion, the character of a cemetery should be that of peace and rest, and everything which we can employ to make it so will improve our rural cemetery.

Rev. Mr. DePeu. May I add one word? I want to speak just to urge one reform, suggested by a word spoken by Dr. Jenkins. As a clergyman, I cannot see sufficient reason for the custom that has long obtained of uncovering heads during the whole of the depositing of the casket and the commitment service. It may be proper to lift the hat, which can be done very slightly, without full exposure of the head, during the benediction. I assume that there is no long prayer made at the grave. It does not seem to me the place for it. The only prayer there should be the benediction, closing the service begun at the house or church. But as to this habit of standing with heads bare during the whole service, it is to my mind entirely unnecessary, inexcusable, reprehensible, for men to so challenge disease. I have, for myself, a little velvet

skull-cap, which I keep on. I have talked with the funeral director in Norfolk about providing similar caps for bearers. I do not know why we cannot come to the understanding that there is no lack of respect to the dead in keeping the head covered during the burial.

Mr. Gold. I want to say one word at this time. In my selection of the speaker upon this subject I had in mind an object lesson, the cemetery in Norfolk, where he resides. This cemetery is kept in such a way that there is no distinction between the care that is bestowed upon the graves of the rich and the graves of the poor. The grass is just as neatly trimmed in the remotest corner of the ground, which is quite extensive, as it is on the choicest plots of those who are the nearest and dearest friends of the parties who have the cemetery in charge. I never witnessed anything like this in any of the large cemeteries of the country. It has always been a shock to me to see the extreme care some bestowed upon their plots, while they left the graves of their neighbors neglected and grown up to weeds and coarse grass. There is nothing of that kind to be seen at Norfolk.

Rev. Mr. DePeu. I am a little like Banquo's ghost, that will not down. Since Mr. Gold has spoken of Norfolk, let me speak of one thing. In Norfolk we all have pauper burial, if you wish to call it so. The town buries everybody. The town digs the grave; the town furnishes the hearse; and the richest man, like the man who is brought from the town farm, is buried by the town. We have tried to hold to that idea that we are one in death.

Mr. Hubbard. I confess a little surprise that the question should be gone over so thoroughly and no allusion made to what is to some a most tender association connected with our rural cemeteries, and of a great many rural cemeteries of this State, and that is, the exercises of the 30th of May, Memorial Day. I think that the improvement of our cemeteries is owing very much to the action of a body of men who felt that they owed to the dead comrades

some recognition, and who chose to make it by going on the 30th day of May of each year to the cemeteries and placing some little memento on the graves of departed soldier comrades. See how that custom has been followed. It is not now the old soldiers alone who gather there; it is associations of a great many different natures and characters. But there was the seed of it all. Memory for those with whom you were formerly associated, between whom and yourselves there grew up, some way or other, strong ties, and the thought that although parted by death, there was still the tie of friendship, of memory, of association. It, perhaps, needed some strong tie in order to set this thing in motion; and the tie that was welded in the fire of battle proved strong enough for that. I do believe, as I have said, and I repeat the same, that we owe very much of the improved condition of our cemeteries, of the new interest that is felt in them, to the action of the members of the Grand Army of the Republic in establishing Memorial Day, and in continuing to observe it from year to year as they do. The time will soon come when that observance, so far as carried on by the surviving soldiers, will cease. Perhaps some organization of men will continue to visit the graves of the old soldiers; but whether they do or not, I think the idea has taken root and will bear good fruit, that there will be refreshened memory of the dead, pleasant memory of the dead, and that it will lead to more care and more attention to our cemeteries, so that they will be places of pleasant association, of attraction, or something that will elevate and refine the characters of those who visit them.

Mr. Brown. The hour for adjournment having arrived, we will have some music from the orchestra.

(Music.)

At 9:40 adjourned to 10 A.M., to-morrow.

MORNING SESSION.

December 16, 1896.

(Music.)

Vice-President Brown. Ladies and gentlemen: I have the pleasure of introducing to you this morning the Hon. William B. Sprague of Andover, a member of the State Board, who has kindly consented to preside at our morning session.

Mr. Sprague. Mr. Chairman, ladies, and gentlemen: I am glad to welcome even so few here this morning. It shows an interest in the cause when even so few brave the storm. Now, the first on our program this morning is a lecture entitled "Experiment Stations and Progress in Agriculture." This subject is assigned to Charles D. Woods of Orono, Maine. In introducing the gentleman from Maine it would seem that I was introducing a stranger. I think it should have been, "Prof. Woods from Connecticut," and then we would all know him. He needs no further introduction than to say "from Connecticut."

EXPERIMENT STATIONS AND PROGRESS IN AGRICULTURE.*

Prof. C. D. Woods, Orono, Me.

Mr. President, Ladies, and Gentlemen:

I came here to-day hoping that I should have the opportunity to speak to a much larger audience, which would include more especially those who do not altogether believe in experiment stations. I must, therefore, beg indulgence of you who are so interested in experiment station work in this State, while I briefly review the history of the experiment station movement and attempt to show a few things the stations have accomplished and point out what the limitations of experiment station work are.

The first agricultural experiment station in the world was established less than fifty years ago in the village of Moeckern,

* This is an abstract, prepared by Professor Woods, of the address which he gave before the State Board.

Germany. A company of farmers, believing that science could help agriculture, formed an association, engaged a chemist, and put him at work to investigate some of the problems which underlie agriculture. In Germany, Leibig; in France, Boussingault; in England, Lawes & Gilbert; had been at work opening up the road whereby agriculture might be benefited by science. This station at Moeckern was established in 1851. It proved itself to be of so much value that the number of stations multiplied rapidly, so that in 1861 there were fifteen experiment stations in Germany and other European countries, and to-day, on the continent of Europe, there are over one hundred stations.

The history of the experiment station movement in this country is familiar to you. Connecticut has the honor of initiating the movement. Secretary Gold, Professors Johnson and Atwater, and others, something over twenty years ago worked for the establishment of the experiment station, and through the liberality of Mr. Orange Judd and an appropriation from the Connecticut Legislature, the first agricultural experiment station in America was started in the Chemical Laboratory of the Wesleyan University at Middletown in October, 1875. The history of the experiment station movement in this country is a repetition of its history in Germany. In less than two years of its experimental existence this experiment station demonstrated so clearly its value to the agriculture of Connecticut that the Legislature of 1876 passed an act establishing the station on its present permanent basis. Stations were established in other states, so that in 1870 there were seventeen stations in this country in fourteen different states.

The cause of agricultural education had been greatly advanced by the establishing of the land-grant colleges. The experiment station movement commended itself so generally to the country that in 1887 the Hatch Act was passed by the United States Congress, which act, under certain conditions, appropriates $15,000 per annum to each State and Territory for the establishment of experiment stations. As a result of this, experiment stations have been started in nearly every State and Territory. To-day, not counting sub-stations, there are fifty-four agricultural experiment stations in this country, fifty-one of which receive the appropriation provided in the Act of Congress referred to.

The experiment station movement has extended into all

parts of the world, so that to-day we find experiment stations on the continent of Europe, Asia, Africa, Australia, and both the Americas.

The experiment stations of the United States employ more than five hundred and fifty men. The total revenue of the experiment stations from all sources is nearly a million dollars.

This is an enormous amount of money, and this question at once arises in the mind of one studying the experiment station movement, "Is this great cost justified?" Here in Connecticut it is hardly necessary to answer this question. It is a recognized fact that along the lines of fertilizer control alone, the experiment station has saved to the farmer of the State many times its cost. This same fact holds in nearly all of the States east of the Mississippi. Wherever fertilizers are used to any considerable amount we find the control station and the annual saving along this line alone is much greater than the total cost of the experiment station.

A method of analysis in common use and so simple that a man of common intelligence can work it — the Babcock Test — originated with an experiment station man, and was a gift to the dairy public. This one gift of the experiment station to the dairy public has, in my opinion, been of far greater value to the dairy industry than the total cost of experiment stations up to this time. It would take too much time to mention the numerous ways in which experiment stations have been of decided pecuniary benefit to agriculture. Spraying for fungi and injurious insects, which methods of protection are the result of experiment station work, saves annually many times the total cost of maintaining stations.

Not the least part of the work of experiment stations is educational. Twenty-five years ago it was practically impossible for an ordinary farmer to obtain information concerning agriculture and the principles which underlie it. There was no agricultural literature. How is it to-day? There is an enormous literature — valuable literature — which is at every man's disposal; it is to be had for the asking. Every experiment station is required by law to publish reports and bulletins of its work. In 1894 the experiment stations issued fifty-four annual reports and over four hundred bulletins, and there were distributed, in the aggregate, nearly five million copies of these publications in the United States and Territories. The station bulletins are regularly distributed to a

half-million persons, who are either farmers or closely identified with the agricultural industry. The kinds of experiment station work is discussed in thousands of newspapers. One experiment station (New York, Cornell) estimates that each one of its publications, directly or indirectly, reaches more than a half-million readers. Besides this the experiment stations carry on a very large correspondence with farmers. Hundreds of public addresses are made by station officers at farmers' meetings, and the results of station work are taught to thousands of students in our colleges.

The stations have also taught the farmers how to help themselves. In many lines their work has shown that to be thoroughly successful the farmer himself must be an experimenter. The stations have found out things which are of great economic value, in the study of soils and fertilizers, in the tests of new varieties of cereals, forage plants, vegetables, and fruits; in research upon the composition and digestibility of feeding stuffs; in feeding experiments with sheep, pigs, and dairy cattle; and in investigations in dairying; and in observations in plant diseases.

The problems which the experiment stations undertake to solve are many. They refer to the tillage of the soil, to the nature and action of manures, to the culture of crops, to the food and nutrition of domestic animals and man, to the production of milk, butter, and cheese, to diseases of animals and plants, and, indeed, whatever the farmer needs to know and science can discover.

The national appropriation comes to the experiment station for a distinct purpose, and cannot properly be used for police work. Fertilizer controls, seed controls, study of food adulteration, and the like must be supported from other sources. The $15,000 per year derived from the funds under the Hatch Act is spent in investigation of problems pertaining to agriculture and in distributing information regarding these problems and the results of the investigations. Hence, it is not to be expected that a station maintained by the national fund should do police work.

What kind, then, of investigations shall the experiment stations undertake? In the first place, except under extraordinary conditions, the experiment station should not perform experiments of such a nature that the farmer can readily make them for himself. Many kinds of field experiments

are better made by the farmer than by the station. Frequently it is important that the station should help the farmer make the experiment, but since the results of such experiments are only of local benefit, it is better that they should be performed by farmers, instead of by the station.

The kinds of work which the stations do ranges from simple experiments, such as ordinary variety tests of vegetables, plants, and animals, to the most complicated kinds of research.

Our stations are, many of them, making simple experiments. The studies which the Storrs Station is making of the feeding practices of the farmers of Connecticut comes under this head. Such experiments are simple and easy, and for the most part readily commend themselves to farmers. They can easily see the meaning of such experiments, and many a farmer and practical dairyman think that these are among the best work which the Storrs Station is doing. In my opinion, these are among the lowest and least valuable of the things which it is accomplishing. Other work, such as the study of fungous diseases, the study of insects injurious to vegetation, and many other technical kinds of work are of more importance, but I believe that the best work the experiment stations will, in the long run, do for agriculture is along the lines of much more abstract inquiry. Instances of such kinds of work are found in the study of proteids conducted at the Connecticut Experiment Station, the experiments in bacteriology and with the respiration calorimeter which are being conducted at the Storrs Station. The results of such inquiries are not always apparent to the layman. For example — I draw most of my illustrations from the two Connecticut Experiment Stations, and largely from the Storrs Station, whose work I know the best — when we commenced to study the acquisition of atmospheric nitrogen by plants, if the ordinary farmer had seen all the steps and precautions used, such as carefully sifting, washing, and burning ordinary sea sand; placing it with great care, so that it should neither be too compact nor too loose, into glass bottles; taking ten or fifteen minutes to plant a diminutive pea plant in one of the jars; carefully measuring everything, even to a drop of water given to the plant; and watching its growth through weeks and months daily and almost hourly; it would have seemed to many almost as though it was agriculture "gone silly," and yet just such painstaking inquiry was needed in order to dem-

onstrate whether or not plants are able to acquire nitrogen from the air. By such experiments it was found that the legumes, such as peas, clovers, etc., alone have this remarkable power of acquiring atmospheric nitrogen.

I suppose that when some of you receive the reports of the Connecticut Station, you are a little disturbed because so much space is taken up with the account of the abstract inquiry into the composition and nature of the varieties of proteids of wheat, oats, and seeds of various kinds. This is, however, among the best work that station is doing, because it is work which is fundamental. In order to obtain an adequate understanding of the nitrogenous constituents of foods, just such work is necessary. Farmers have learned to talk glibly enough of protein, and most of them think of it as a definite chemical substance. When it is understood that the term protein is used to designate a large number of very different kinds of matter and that the knowledge of the percentage of protein in the feeding stuff is obtained by determining the percentage of nitrogen and multiplying this number by an arbitrary factor 6.25, it is evident that just such fundamental inquiries are necessary to help solve the problems of feeding.

The study of the bacteria which exists in milk and have to do with the ripening of cream and the manufacture of butter and cheese have been carried on successfully at the Storrs Station by Professor Conn. The reports of that station for the past few years have contained long technical descriptions of these bacteria. Page after page of these reports is taken up with material of this kind, and, perchance, the farmer may say, "What have I to do with such trash as that?" But that kind of work is necessary in order to find out about the ripening of cream in butter making, and the result of these investigations, which seem at first sight to be of little or no practical use to the farmer, are coming into every-day practice.

There has been for years being developed in Judd Hall, at Middletown, a respiration calorimeter, — the name of a piece of apparatus which has but little meaning to many. This investigation involves problems so complicated and questions so intricate that it is practicably impossible to explain to a popular audience what they are, and yet as complicated and as abstract as that inquiry is, it is the kind of work which is to help us to understand the problems which underlie the ordinary feeding of milch cows and other animals.

Here in Connecticut it is hardly necessary to defend these abstract kinds of inquiry. I want, however, to urge upon any one who may be disposed to question the value of this kind of work that it far transcends in importance the work which seems to bring immediate results. There is an experiment station in this country which is publishing delightful bulletins — bulletins which read like magazine articles — they give an inspiration to the farmer to go ahead and make this thing and that thing grow better. As good work as this station is doing in this particular line, it is, in my opinion, doing comparatively little for the real advancement of agriculture. Such work as your stations are doing and which I have tried to outline is vastly in advance of any work which is merely superficial.

Mr. Gold. Professor Woods says that this first Experiment Station in Germany was established in 1851. Soon after that — in 1855 or 1856, the State Agricultural Society employed Professor Johnson to take up the analysis of fertilizers here in this State. We did not lag long behind in catching on to the idea of getting at the bottom of that fertilizer question, and that was often found to be a fertilizer fraud. We had some of the richest developments with regard to attempts of people to impose on well-meaning persons in this fertilizer inquiry that the history of agriculture contains, and a whole hour might be spent in the detailing of those results; and if the audience has time, I think Dr. Jenkins could say a word, before we go on with the Question Box, on this matter of the results of fertilizer control of the Experiment Station, and going back to the work of Prof. Johnson, which was the initiatory step in this matter in this country.

Dr. Jenkins. Mr. Chairman, I was meditating whether I should not get up to say a word on an entirely different subject, and think I could say it without any false modesty, because, while it concerns the experiment station in this State, it does not concern our own experiment station at New Haven.

Looking over the work of the agricultural stations since they were established, it seems to me that, without much ques-

tion, the two most brilliant and far-reaching discoveries, perhaps they may be called—one certainly was—are these: The invention of the device of the Babcock Test, that introduced some rational system where there was no rational system before, in testing the quality of milk; and in the system of payments for dairy products, and more far-reaching in its result than that, the discovery that leguminous crops were able to appropriate in some way the nitrogen of the air. I think I should put that as the most brilliant and far-reaching discovery of the experiment station. And that discovery was made at the Storrs Station, or previous to the establishment of that station, I think, by Prof. Atwater and Prof. Woods, who were afterwards connected with the Storrs Station; and I think this ought to be clearly in our minds, that that is the work of American experimenters. Any one who is familiar with the literature of the subject in England, France, and Germany will notice that credit for that discovery is taken entirely by German experimenters, and scarcely any reference — only the slightest reference—is ever made to the work of American experimenters. But after the assertion made by Beal, a French chemist, that plants did this, after that was thrown into discredit by the fact that he was an outrageous fraud, and his work was not entitled to any credit, the establishment of the fact that they do assimilate free nitrogen was made by Dr. Atwater and Dr. Woods. Beal had made the statement, but his experiments were faulty, if not thoroughly dishonest. I think that fact should be remembered, and if there is opportunity it should be impressed on European investigators that that was the work of American experimenters.

In regard to fertilizer control, it seems to me that is rather old straw to thresh now, not because I would slight it myself, as I believe it has been of incalculable value to all, but it seems to me that all of you are pretty well acquainted with the beneficent results of that fertilizer control work, which was begun long ago, in the '50's, and has been carried on with

little interruption ever since, and which I think is one of the seeds planted from which this experiment station work has developed; that is, it first showed farmers that there was a practical value in scientific work and investigations, — in chemical work. It was not what you would now call scientific investigation, but that a man of science, who knew nothing of practical agriculture, should be called in to assist the practical every-day farmer, and save him dollars. When this was accepted, then we were ready to accept the aid of scientific men in other directions — at least to try him and see whether he was worth his feed in other departments of work. I don't know that I need say more about that.

I was figuring a few minutes ago what the amount of fertilizer used in this State was, and the amount of money appropriated by the general government and the State of Connecticut to support the Connecticut Station, which is charged with the work of fertilizer control. Suppose that every cent of that money appropriated by the general and State governments was expended in the examination of commercial fertilizers and the report of the results. We spend more than $750,000 in cash annually for commercial fertilizers. We will say our station costs the State and general government $20,000 a year. That would amount really to about one dollar per ton for all the fertilizers bought in the State. Supposing there was nothing done but fertilizer work — which is really now a small part of the work — we should be paying a dollar for every ton of fertilizers sold in the State. I think it is hardly too much to claim that one dollar per ton spent in the inspection of fertilizers saves a great deal more than that in the general aggregate sold in the State. We have no fraudulent fertilizers in the State. We do have such fertilizers introduced every few years, perhaps every year, but you will find that they disappear from the State and are not used. Why? Because they are inspected, and the quality of them made known.

Mr. ———. I would like to ask Dr. Jenkins a question in regard to bacteriology so far as the clover plant is concerned. Prof. Atwater alluded to bacteria yesterday in regard to that study. As many of our farmers know, it is hard work many times for us to get a catch of clover. I would like to ask the question, If, after once getting a good stand of clover, the bacteria from that clover will last through the rotation of two or three years, so we can be insured of a good stand in the succeeding crop?

Dr. Jenkins. So far as I know there are no experiments as yet from which we can decide whether that is the case. Other things being equal, I believe you would be more apt to get a good stand of clover after a three-years rotation of land where clover has been grown before, than on land where clover had not been grown. I say, other things being equal, which is granting a great deal. A great trouble in getting a good stand of clover is that the land often does not contain sufficient lime. To get a good stand of clover, you have to have soil with considerable lime in it. I was interested in what Mr. Hoyt said yesterday, that he found ashes a great help. Our ordinary Canada ashes contain nearly two-thirds of their weight of carbonate of lime. We know that where land has been used for clover a little of the surface soil may be used with good effect in inoculating soil where clover has not been grown. But as to how long inoculation with special bacteria, how long that helps the clover crop, I don't think has been determined.

There is one point in regard to the action of bacteria and action of legumens in laying hold of the free nitrogen of the air, which should be emphasized more than it has been. My attention was called to it by an account in the *Rural New Yorker* a while ago. It should be remembered that you cannot go on with leguminous plants indefinitely increasing the supply of nitrogen in the soil. It is only when the soil is quite deficient in nitrogen that these plants will take up the nitrogen to any amount. When you get the soil right it will feed on

the nitrogen that is in the air. So, if you are using clover crops — leguminous crops, I mean — to enrich the soil in nitrogen, be sure that the soil contains an abundance of phosphoric acid and potash before you seed down.

Prof. Woods. The clover plant, in its early stages, does not seem to be able to shift for itself in gettting its nitrogen, even though there are bacteria present, which aid later in acquiring nitrogen. In the clover plants we had success with, it was necessary to start them in sand containing nitrogen in soluble form. As soon as the plant got to be 3 or 4 inches tall it was apparently able to acquire its nitrogen from the air. I should think if one desired to get a "catch" of clover on soil deficient in nitrogen, it would be wise to use a small quantity of soluble nitrogen to enable the plant to get started. This is founded upon pot experiments, and not on field experiments.

I want to say just two or three things about agricultural education — things that seem to be a little bit heterodox, and other things that seem to be extravagant. We sometimes look at agricultural colleges and say, "Where are your farmers?" We forget that all of our agricultural colleges are established under the Morrill Act, which says that these institutions, when founded, shall teach the branches of learning related to agriculture and the mechanic arts. Our land-grant colleges should not expect all of their graduates to turn out mechanics or farmers. They are to teach the branches of learning related to agriculture and the mechanic arts. That is, I think, a thing we want to understand; and we want to understand clearly that while it is desirable that we have educated farmers, it is more important that we have educated agriculturists. Take, for instance, the State from which I come here to-day. We have got a large college, so-called State college. Not more than five per cent. of our students go into the agricultural course. I don't know how small a per cent. of that five per cent. it would be that actually turn out to be farmers. Now, that may seem to be a little bit singular. In the first place, why do not the men who

take a four-years training in the sciences which pertain to agriculture, go to farming? Farming is a business, and farming requires capital. The young men who take a four-years course in our colleges find that if they are going to put to profitable use the time and money which they have invested, they must have capital, or else they must go into some other lines than agriculture. So that it follows that the graduates turn to other lines of work; or if they keep on with agriculture, take, for the most part, lines of work related to agriculture, such as experiment station work, teaching in colleges, and work in the agricultural department of the Government, whereby they become specialists along agricultural lines. That is a thing we might as well look in the face. If a man is going to put into successful practice all he has been able to get out of his college course he must have capital. Shall we stop our agricultural departments of education? No. I say it is more important to maintain them because of few students than if they were crowded with students. This is the leaven which is to leaven the whole. It is these few men that go into agriculture that are to elevate agriculture. Twenty-five years ago you could pick out a farmer wherever you saw him. To-day you cannot. The science of agriculture has brought that about.

Now, let us rally around the agricultural department of the colleges, and around the Agricultural College of your State. Try to make it a college in fact as in name. Remember, its business is to teach the sciences related to agriculture and mechanic arts, and not, primarily, to make farmers or mechanics.

Prof. Gulley. Prof. Woods has left out one point. Three of the Western colleges have been running twenty-five or thirty years, and turning out graduates, and what has become of them? We know graduates do not all follow farming. And the same excuses have been given. These graduates now have been in business, many of them, fifteen, twenty, twenty-five, or thirty years. It is found that the percentages of this

class has increased all the time in the direction of agriculture, no matter how they started out. I am pretty familiar with the statistics from Wisconsin, and it is found that after ten years, if they had time, they went back into the agricultural lines. Most of the boys were poor and could not buy a farm. As some other business gave him a start, he was able to build up. In the States of Iowa and Kansas, statistics show, those graduates who are over ten years out, the percentage to-day is very much larger in every class than when they began. They are working into that as time and capital give them opportunity. So this work is not lost, although it appears at first to be perverted.

Mr. Gold. I want to say, in regard to the Storrs Agricultural College, that I believe the trustees of that institution do not feel so elated with the position of their being in charge of the college as to have closed their doors to the sons of the farmers by too high requirements for entrance. We have not closed that door; it is still open, and we propose to keep it open. While we hope to place ourselves in suitable rank among the agricultural colleges of the nation, we hope to hold our grip on the practical farmers, the sons and daughters of the State, by the course we are there offering. We do not reject the student because he has not gone through all the preparatory course required for the advanced classes. We receive him, of such material as your district schools turn out; and we do not speak very highly in their praise, that they have done very thorough work in those fundamental studies that are supposed to be taught in them. They have allowed some of their pupils to slip along without very thorough knowledge of spelling, writing, and the principles of arithmetic; but we receive them in the preparatory course, and they can go on to the higher course if they please. This is the situation of the Storrs College at the present time, and we hope it will always have its doors open to that class, and with free tuition, and with the opportunities there afforded, the only thing we now

want is more room, more buildings, which the State must furnish; and there is a feeling that it will be done.

Mr. Hubbard. Prof. Woods spoke of the cost, the large amount of money expended from the public treasury in maintaining the stations, and entered into a successful defense of that expenditure, showing that it returned to the people at large, not only all expenditure, but many dollars besides. It is a full and complete defense of the expenditure in that line. But it turned my thought toward the method adopted and maintained for a great many years in compensating those who make new discoveries by another method, that is, by our patent system, that has been in vogue for a long time, which we have regarded as very successful. We have believed it has compensated for all it has cost the people. The cost in that case does not come directly from the public treasury, but we, in effect, say this: "Produce any new discovery, any new invention which is of value and use to the public, and we give you for a term of years the right to levy tribute upon everybody who uses it to the very last extent it is possible for you to do that." Very good. A man takes his privilege, and if it is one that yields him a good deal of money, generally he goes to congressional authority at the end of seventeen years and gets extension of time, and he levies tribute. Tremendous fortunes have been built up in that way.

Another feature of that system is that these tremendous fortunes do not always, or as a rule, go to the originator of the new device or discovery that has proven of so much value: they go to some other man, who has by some means got possession of that invention, or the original inventor has been compelled by suit to transfer it. Or we might say this: "That class of minds which produce new inventions which are of value to the public are not the class of minds designed to make money out of their own invention: they have to pass into other hands before this tribute can be successfully laid on the public for their use." Now, compare these two systems. In one we say "Take your privileges and levy tribute,"

and they do it. In the other we say to the man who is investigating, the man who is qualified to make a new discovery, "Here, go to work for the public, and the public shall pay you for your time, and what you do and discover shall be for the use and benefit of the public." Compare the two systems. Which is the cheaper, and more rational, and wise, and true to follow? Why, it seems to me that the patent system has cost the public at large, drawing the money from those who use it directly, has cost immensely more than our new system. And, looking forward, it seems to me that we shall very likely come to this. I do not like the patent system; there are parts that are extremely objectionable; but we will come to a fair system to compensate. The person who gives to the public an invention like the Babcock test should be paid; but it was freely given to the public, because the man had this spirit in him, that he was in the service of the public; he was paid to investigate what he ascertained, and it was not to be used for his own benefit, but for the benefit of the public. Compensate those who are making new discoveries, but do not give them the privilege to levy tribute and subject those who need have and use these discoveries to such tremendous cost and compensation for this use.

Mr. Gold. The Question Box is called for.

QUESTION BOX.

Mr. Gold. "Will peach trees grown in the South or West, where they do not have the Yellows, withstand the disease if planted here?" Who is there to answer that question?

Mr. Hubbard. No.

Mr. Hale. I simply indorse what Mr. Hubbard says. I do not think they would withstand the disease here any more than any others. I think they would be safer to plant here because free of the disease to start with, and planted in unaffected districts they would be less likely to have it for a greater term of years. But plant them in close proximity to diseased trees and they would have it sooner or later.

Mr. Hoyt. I wish the one who put that in would state in what part of the West they do not have the Yellows.

Mr. Platt (Milford). I put the question in. I understand that in California and Missouri they do not have the Yellows. I understand they do not have it in Texas, Florida, or Georgia.

Mr. Hoyt. I think if those Southern trees are brought here, and from those states mentioned, if they will bring their climate with them, they won't have the Yellows; but unless they have their climate, if they come into our cold climate, they will have the Yellows the same as ours do.

Mr. Gold. "Which is the best way to kill potato bugs?" Practical farmers ought to be able to answer that.

Mr. ———. A gentleman on my right says "with a hammer." He is a practical farmer.

Mr. Gold. Is that the way he does it? A great many devices have been used; applying Paris green dry, or Paris green wet? The mode of application seems to be the question. It is pretty well settled that the chemist cannot give us anything better than Paris green.

Mr. ———. One of the Paris green blowers would be the best; but if on a large scale, get a horse-power sprayer that will take about six rows at once.

Mr. ———. Any one who has a few acres of potatoes can take one of several different kinds of blowers and put it on dry, and go out early in the morning when the dew is on and kill the bugs cheaper than any other way.

Mr. Stanley. You know your employes are not to be trusted in every particular, and you will find it cheaper to have it applied with a more laborious process, but whereby you can see from looking over the field that it has been done; because otherwise you will send a man into the field and he will roost on the fence, and the potato bug continues industrious, and in two or three days the crop is gone.

Prof. Woods. It is always a desirable thing, if we are going to use the insurance method, to apply Paris green and the

Bordeau mixture at the same time. That reduces the work considerably. In Maine, where they depend largely on the potato crop, they feel it is necessary to put in that insurance in most every instance, even though we knew we were going to have a season tolerably dry. Last year there was practically no trouble with the fungus disease in Maine; yet you will find the growers this year are going to use Bordeau mixtures as before.

Mr. ———. I had a horse-power sprayer I used a year ago on twelve acres, and, after the Bordeau was prepared, I could spray the whole twelve acres in half a day, and did it myself.

Mr. Fenn (Milford). This summer has been unfavorable for the application of Paris green dry, for the reason that we had so frequent rains it was almost impossible to get two days at a time when it would not wash off; but with the Bordeau mixture it will remain there a long time. Some of the Bordeau mixture I applied to apple trees, when the apples were about the size of hickory nuts, and it was on the apples when I picked them. So you see it holds.

Mr. Gold. Does Mr. Fenn have any trouble in the Bordeau mixture obstructing the sprayer, and settling in his pipes, and getting dry and hard, forming an obstruction to the spraying apparatus? How do you get along with that?

Mr. Fenn. I have very little trouble if I am particular about running it through a fine mesh, to remove all the lumps. Then I use a nozzle which has a little plug, that you have only to touch to remove the obstruction.

Mr. ———. I think that half of the work is to see that it is thoroughly strained in the first place. If you spend more time in straining you will have to spend less in spraying. If you have a strainer made of brass, and strain through that, you will not have trouble with clogging of the pipes. You must have something fine or you will be bothered more or less.

Mr. Fenn. And you should thoroughly wash out the pipe and nozzle after using.

Mr. Gold. "Is there danger of over-production of peaches in Connecticut in the near future?" Mr. Hoyt, do you anticipate any?

Mr. Hoyt. No, I do not.

Mr. Hale. I question whether there is likely to be any over-production of good peaches for some time to come. Probably Connecticut will, in a few years, produce more peaches than it has any local market for; but there are abundant markets within easy access, where they cannot be produced. We have the New England states to the north, and Canada and New York with later varieties. I presume the price in the future is not going to be so profitable as in the past. I believe the production of peaches in Connecticut will come down nearer to that of staple farm crops in profit. But I believe there are plenty of markets for all likely to be produced for years to come for the standard and finer kinds.

Mr. Hubbard. I think the Peach Yellows Commission has condemned between 19,000 and 20,000 trees in the past year. We find that in round numbers 200,000 new peach trees were planted in Connecticut in 1896. The extension of peach culture in Connecticut is very great and very rapid, and bound to continue so. Information comes to me from this man and that, and the other, that they mean to plant 2,000 or 3,000, and all know Mr. Hale is going to plant 100 acres with peach trees. As to whether it is going to be overdone or not I do not know, but to go back to something I said yesterday afternoon, I would say this in general, that if everybody could buy and eat all the peaches they want and that would be good for them, it will take us a long while to reach the point of over-production in Connecticut.

Mr. Hoyt. The only way for a farmer to have peaches is to set out the trees, and when we hit a good year we will have them, and when the frost kills the buds we will not have them. It was no fault of the Yellows that we had no peaches last summer; it was because the buds were killed. There were quantities of trees formed their buds, but the winter killed them.

What is the prospect this year? Our fall so far has been unfavorable. The weather we had on Saturday and Monday, and all last week was warm. What effect it had on the peach buds I don't know, or how much cold weather we will have now to injure those buds I cannot tell. They may be destroyed this winter. I know these things do follow in sort of decades. In 1878, 1879, and 1880, there was an abundant crop of peaches. After that we had four years, I think, in which there were scarcely any. Then it "caught on" again, and for a series of years we had peaches. And that is the way it seems to work. But I think one does not need to be discouraged from setting out trees because we fail to have peaches for one year, or two years. If we have the trees and the season is right we will have a crop of peaches. I do not anticipate any over-production in the State of Connecticut.

Mr. Brown. In regard to the question of trees brought from the South or West escaping the Yellows, I would inquire if anyone attributes the Yellows to the climate?

Mr. Hubbard. Peach Yellows originated — I am not able to give dates — but it is something limited to the United States, perhaps, and Canada, to this continent, and this portion of the continent; it was first observed about fifty or seventy-five years ago, in some limited locality, and it has from that time spread until now it covers the northeast section of this continent quite generally, and has extended into Canada. General facts seem to give it the character of a contagious disease. Warm climate does not stop it. It is spreading South. Delaware and Virginia give testimony of that fact. It is spreading West. It is in the vicinity of the Mississippi River. It has gone into Canada. And there is nothing in the history of its development and spread which gives any reason to believe that it is a climatic disease; that warm climates are to be exempt from it, or cold climates are to be subject to it.

It is a good thing, as Mr. Hale has said, to be sure when you plant your trees that they are free from the contagion; but we cannot assume that the climate in which they are grown gives

them any immunity from contagion if they are exposed. We must guard them by other means. We know Connecticut is pretty thoroughly infected with the Yellows. It has been for a great many years. The disease has become thoroughly established here. We are making strenuous efforts to stamp it out. We are making progress in that way.

Mr. Peck. I would like to hear from Prof. Gulley on this point. I think he is familiar with this subject.

Prof. Gulley. I can only repeat what Mr. Hubbard has said. We have been following this since 1876. I do not believe there is anything to show that climate controls it in any shape or manner. The point as to where the tree comes from is unimportant. There is no question but the disease is working South, and we have no reason to believe it will not get over the mountains some time. It has not yet, so far as we know. There is nothing to indicate in the history of it in Michigan or in the other states that it is a climatic disease at all. I am a thorough believer in its being contagious, and it must spread from one tree to another. I am not going to tell you how, because I don't know, and do not believe any one else does. I believe it is contagious, and that the climate has nothing to do with it.

Mr. Averill. Our law in this State creating the Peach Yellows Commission is based on the claim that it is a contagious disease. Now if this is not the fact, and the disease is caused by the climate, something in our climate, then I am in favor of repealing this law. I think that our bacteriologists and scientific men should study this disease.

Mr. Hale. I certainly agree with Prof. Gulley and Mr. Hubbard that there is no question in the minds of observing men but what this is a contagious disease; but it may be also true that a contagious disease may be affected by a climatic condition. A certain disease will thrive under certain climatic conditions, and die under others. Peach Yellows, I think, is in a measure affected by climatic conditions. Our friends speak of it as extending South; so it is and has been for twenty-

five years; but it is keeping up along the Blue Ridge and Alleghany heights of North and South Carolina, and in some portions of Tennessee and Kentucky; it is in the sections where they get at times extremely cold weather. It has never struck into a section where they have a temperate climate.

Mr. Sprague. I think we will close the Question Box now, as the dinner hour has arrived, and take a recess until 2 o'clock.

(Recess.)

AFTERNOON SESSION.

December 16, 1896.

(Music.)

Mr. Brown. . Ladies and gentlemen, I beg to introduce to you Mr. William H. Hammond, member of the board from Windham County, who will preside at our session this afternoon.

Mr. Hammond. The lecture this afternoon will be entitled "Silage and Silos," by Prof. Charles S. Phelps of Storrs College.

SILAGE AND SILOS.

By Prof. Charles S. Phelps, Storrs College.

Mr. Chairman, ladies and gentlemen: In looking over the program that your secretary has prepared for you, I see he has placed me in a rather peculiar position, and if I leave you this afternoon in a peculiar position you must not blame me for it. As I look down the program I see "Charles D. Woods, Orono, Me." Just below, "In the Woods, by William E. Simonds." I seem to be pretty near the woods, and if I leave you in the woods on this subject you must lay the blame to the subject rather than to me.

In taking up this subject of "Silage and Silos," you must remember that this is an entirely practical question, and if I prove weak on some points you must ascribe it to my inexperience in practical matters. I must treat the subject from

general principles rather than from the practical application of them. You who are from day to day interested in matters of the farm must apply these principles in practice.

The silo was originally nothing more than a tight pit or cellar used for the storage of grain. In certain Eastern countries this method of preserving grain was in use in very early times, the chief object being to prevent marauders or victorious enemies from gaining possession of the stores. In ancient Egypt solid chambers of masonry were a common means of storing grain, and in recent times well preserved grain has been found in some of the tombs, which must have been there not less than 4,000 years. The Moors are said to have introduced the practice into Spain, and in that country it acquired a commercial importance as a means of holding grain from years of plenty and low prices to years of scarcity and high prices. From Spain the practice found its way into France, but was slow in gaining a foothold, although in modern times it has been largely used at the stables of the Paris Omnibus Company. It is worthy of note that this method of storing grain has been in use chiefly in arid countries, or those of little rain-fall. In humid climates the greater amount of moisture in the silo, and in the grain when ready for storage, caused an amount of fermentation sufficient to injure the quality of the product. Doyeré, in his report to the French Government, published in 1856, on the "Preservation of Cereals," showed that wheat containing much over sixteen per cent. of moisture could not be preserved in silos without first being dried, and in any case it was difficult to keep the air of the ordinary silo of masonry sufficiently dry to prevent serious fermentation. To overcome this difficulty Doyeré proposed employing metals. His system of constructing the silo was to line it with thin sheets of iron preserved on the outside by a sort of varnish impervious to water. This was enveloped by concrete or masonry. By this means external moisture was excluded, and the grain was well preserved, if quite dry when placed in the silo.

The preservation of green fodders in the silo is a comparatively modern system, although there is some evidence that fodders were preserved in pits in the ground by certain tribes of Northern Europe many years ago. The first description of the process dates back only to 1842 or 1843. In the latter year Prof. J. F. W. Johnston, in the report of the Highland Agricultural Society, describes the German system of storing

grass and other green crops in pits dug in the earth. These pits were lined with wood and puddled with clay. The grass was put in in layers and sprinkled with salt, each layer being thoroughly trodden before a new one was added. The pits were covered with a tight lid and weighted with earth. When the silage had become well settled, the silo was commonly uncovered, refilled and covered again as before. These pits were kept covered at least six weeks, after which they were opened and the silage was fed from the different pits successively. Good results were reported from the use of this "sour grass" by many German feeders.

The use of the silo for the preservation of fodders other than "sour grass" appears to have been commenced in 1861 by Herr Reihlen, of Stuttgart, Germany, who first published an account of his method in 1862. Herr Reihlen adopted this method of storing fodders for the purpose of preserving the leaves of beets for use in feeding during the winter season. Beets were at this time being quite extensively grown for the manufacture of sugar, and it was found difficult to utilize the leaves in a fresh state, to the best advantage, in feeding to the working cattle, as the animals needed a more nutritious ration when employed at farm work during the autumn. It was thought that if this same fodder could be made available for feeding during the winter season, when the oxen were being kept "in store" or were being fattened, it would prove much more valuable and economical. This led Reihlen to experiment with the silo, which he did with considerable success, and before 1862 had used it to the extent of preserving the leaves of 400 acres of beet roots. Reihlen had traveled in America, and become familiar with the value of maize in this country. In his own country, however, he found that the grain did not always ripen, and he tried the storage of the entire crop in the silo with marked success.

In 1867 Count Roederer, in the department of Orne, France, began the preservation of maize in silos by chopping and mixing it with cut straw. Another Frenchman, M. Moreul, shortly after 1870, used the silo as a means of preserving unchopped but salted maize, and it is said that he practiced the system with great success.

Nearly all of the early writers on silos and silage in America give Goffart of France the credit of being the originator of this system of preserving fodders. The first edition of his book,

in which he describes the process, appeared in 1877, and it will be noticed that at least three others, two Frenchmen and a German, preceded him in experimenting along this line. The great merit of Goffart's book was that it was the first detailed record of the process of making silage from green maize. Goffart at no time claimed to be the originator of the system; his writings have simply been misinterpreted by American writers.

The first silo built for the preservation of green fodders in the United States, was constructed by Dr. Manly Miles of Michigan in 1875. Francis Morris of Maryland commenced experiments along this line in 1876, and several silos were built in the Eastern states during the next few years. In 1882, in a report on silage by the United States Department of Agriculture, statements were published from ninety-one persons who had silos, and probably this number covered the greater part of the silos then in use in this country. It is interesting to note that of the ninety-one silos reported upon, seventy-four were located in the New England States and New York.

At the present time the silo is found on hundreds of farms all over this country, and is considered an almost indispensable adjunct to successful dairying. First introduced into the East, it has gradually spread into the Western States, and has there been taken hold of with even greater energy than in the East.

EXTRAVAGANT CLAIMS MADE FOR THE SILO.

One drawback to the introduction of this system of preserving fodders in our own country was the extravagant claims made for the method by a few enthusiastic admirers and others who, for financial reasons, desired to " boom " the system. The false teachings put forth by some of the early advocates of the silo turned many against the method. It remained for scientific investigators to take up the subject and to show what some of the processes and changes which occurred in the silo were, before the true merits of the system were made known. The claim made by some of the early writers on the silo in this country that, in some mysterious way, the fodder was greatly improved in feeding value by the process of siloing, was soon overthrown, and the real merits of the silo, as compared with the method of drying fodders, were shown to be based on the principles of economy. To-day the teachings of science show

us that the changes which take place in the silo can add nothing to real nutritive value of the fodder but instead cause a constant loss of food materials. It is probably true that the palatability of the silage is greater than that of the same fodder when dried, and that the animals will eat proportionally more of it; and the fact that palatability is a matter of considerable importance in the results obtained from feeding, must be kept in view. It constitutes a strong argument in favor of silage over the same fodder when dried.

FORM OF SILO.

The form of the silo is a matter of no little importance, from the standpoint of economy, and for preventing wastes and losses.

The round silo seems to be the ideal form. In this the entire absence of corners reduces the waste very materially, and the space contained in the silo is most economically used. After the round, the square silo is the most desirable form, while the rectangular is the least desirable. The nearer the rectangular silo approaches the square, the better it will be. The smaller the proportion of silage there is exposed to the outside wall, the smaller will be the loss, hence large silos are more desirable than small ones. It has been found that the loss of food constituents is much greater near the exterior of the mass, while at considerable distance from the outside walls the loss is greatly reduced. In all cases the silo should be deep, in order that the pressure caused by the weight of the silage may be heavy, an important condition to aid in the exclusion of the air.

MATERIALS USED IN THE CONSTRUCTION OF THE SILO.

The first silos constructed in this country were made almost entirely of masonry. It was thought that solidly built and cemented walls of stone or brick were essential to the preservation of the fodder. It soon became evident, however, that wood silos, when carefully constructed, would make as perfect silos, as far as the preservation of the fodder was concerned, as those made of masonry. There is one very material advantage, however, found in the more solid form of silo. A well-made silo of stone or brick is practically indestructible; on the other hand, the wood silo is more or less attacked by the acids of the silage, and this, together with the extreme changes of moisture between the empty and filled condition of the silo,

causes a somewhat rapid decay. In all cases the silo should be firmly and substantially constructed. The pressure on the walls is so great that much care needs to be exercised to have the studding sufficiently heavy and close to prevent any tendency toward bulging. When building of wood the interior should be covered with at least two thicknesses of boards, with one or two linings of tarred paper between. A wood preservative made from gas tar applied while hot, has been very successfully used. The more completely all of the wood-work is protected by some preservative the more will it resist decay.

A round silo made of staves is a new form which has come into use within a few years, and seems to have many desirable features. It is built on the same plan as the large water-tanks commonly seen along our railroads. The staves can be bought all cut and sawed to the proper length and bevel, and by the use of heavy hoops can be easily and firmly put together. Several of these silos have been built in New York State within the past few years, and have proven comparatively cheap and very strong and durable. Common steam piping which has been drawn down and threaded to take a nut may be used in place of the heavy strap hoops. By passing the threaded hoops or steam pipes through solid pieces of oak, about four inches square, on opposite sides, and by using heavy nuts and washers, the structure may be quite easily and firmly bound together. If it is found that shortly after filling, the pressure is becoming very great upon the sides of the silo, the nuts may be unscrewed, and the whole structure slightly loosened. The staves will frequently so shrink as to leave air spaces between them, while the silo is empty, but this is no great disadvantage if a ready means for tightening and loosening the hoops is provided. With this form of silo there is some danger of the silage freezing in this climate unless a cheap covering with a lining of leaves or sawdust is added.

In the construction of the silo one of the most important parts to be especially well made is the bottom. This should in all cases be first well stoned, then grouted with a mixture of coarse gravel and cement, and finally covered with a smooth covering of Portland cement. The essential points in the construction of the bottom of the silo are to provide thorough drainage and to make it proof against rats.

SILAGE CROPS.

The principal crops available for silage in New England are corn, clover, oats and peas, millet, and soy beans. Corn is the leading silage crop of America. It can be grown upon a greater variety of soils, and in greater ranges of climate than any other forage plant. It will also produce a larger amount of food constituents than any other of our common fodders. Fifteen to twenty tons of green fodder per acre is a fair yield, although twenty to twenty-five tons are not uncommon. There is a great choice in varieties, but few being especially suited to our climate, the Mammoth Ensilage and the Leaming being two of the most desirable kinds. The best variety for any locality is one that will give a large proportion of ears and yet mature before frosts are likely to occur. The most valuable part of the fodder is found in the ears and leaves, so that the largest growing kinds do not always give the greatest food value.

Clover, if well stored, makes an excellent silage; but has not been widely used for this purpose. It is much more valuable, pound for pound, than corn silage. Owing to the fact that it is rich in nitrogen and protein, certain forms of fermentation may go on quite extensively, and bad smelling silage is sometimes the result. This condition has been observed especially in clover stored for a few weeks in the summer and fed during the hot weather of August. To make the best silage, this crop should be harvested when fairly succulent, perhaps before full bloom. It should be finely cut, solidly packed, and after filling the silo, be at once heavily weighted.

Oats and Canada peas may be stored in the silo during July. Like clover this crop has a larger amount of the more valuable food constituents than corn. Yields of ten to twelve tons per acre are readily obtained. Millet has also been successfully grown as a silage crop, although light yields have been a common objection. A new variety, known as the Japanese millet, which gives considerable promise as a forage crop for silage, has been introduced into this country by Prof. W. P. Brooks of Amherst, Mass. It produces very heavy yields, often as high as fifteen tons of green crop per acre.

The soy bean is another Japanese crop, some of the most valuable varieties of which were also introduced by Prof. Brooks. The large green variety has proven most valuable for use in the silo, or for feeding green. It will produce from

ten to twelve tons of fodder, and has a composition much like clover. The crop is quite hardy, having been successfully grown as far north as New Hampshire. The plant resembles a very large bush bean, grows about four feet high, produces a stiff, woody stem, and has a large proportion of foliage. One advantage in the crop is that it will mature at about the same time with corn. This allows of the harvesting and storing of the two crops together. By putting into the silo a few loads of each in succession, a good mixture is obtained, and the resulting silage is more valuable than that from corn alone. Corn silage is especially lacking in the muscle-making constituent or protein, while the soy bean supplies more of this nutrient, and hence the mixture gives a better balanced ration.

TIME OF HARVESTING.

The best stage of growth for harvesting silage crops has been a matter of considerable discussion. The proportion of water in the silage seems to have an important influence in increasing or decreasing the changes that take place within the silo. A very moist and succulent silage seems to favor an excessive formation of acids, while if the fodder is quite dry, it will not pack sufficiently close to thoroughly exclude the air. For crops like clover, millet, or grass, the early blossoming period seems to give the best grade of silage. In the case of corn it is well to allow it to stand until the kernels are fairly well glazed, but not to allow the grain to become hard. If the corn is allowed to ripen there is danger that the fodder will not pack sufficiently close to exclude the air, while the hard grain may not be readily digested by the animal.

FILLING THE SILO.

The extra labor involved in removing the whole corn from the silo is a serious drawback to that method of storing; although fodder corn placed in the silo whole has in many instances come out in good condition. All things considered, however, close packing proves most desirable. Cut fodders can be more closely packed and the air will be more completely excluded than when the crop is put in whole. For these reasons the finely-cut silage will be subjected to a smaller degree of fermentation and the losses should be correspondingly less. The advantages of slow filling as against rapid filling have been strongly urged as a means of procuring a so-called "sweet

silage." The term "sweet silage," however, is a misnomer, when used to designate a definite condition. Such a product as strictly sweet silage never came from a silo, and the term, if used at all, should be one of degree rather than of kind. Slow filling causes a greater degree of heat to develop in the silage, and this tends to soften the mass and cause closer packing, while the high temperature does not favor the formation of acids. At this high temperature, 135 to 150 degrees F., certain forms of fermentation often progress rapidly, and the fact that less acid is formed when slow filling is practiced, does not prove that there is a smaller loss of food constituents during the siloing process.

CHANGES IN THE PROCESS OF SILOING.

The changes which take place are extremely complex, and up to the present time scientific investigations have thrown little light upon the exact causes and the nature of such changes. The transformations occurring in the fodder while stored in the silo, with the exceptions of the moulds which form near the outsides of the mass, are mainly due to bacteria and must be studied from the bacteriological standpoint. If the conditions are such as to favor the development and rapid growth of many kinds of bacteria, a correspondingly large loss of food constituents will result. But if conditions are provided that will tend to reduce the activities of the bacteria to a minimum, a fairly well preserved silage should be obtained. One of the first changes which takes place in the silo is the conversion of a part of the starch and sugar into either lactic or acetic acid, or both. The formation of these acids is necessarily brought about at the expense of food constituents. A certain degree of acidity, however, appears to be desirable as the activities of other more destructive kinds of bacteria are checked, the acid seemingly acting as a sort of preservative. The presence of large quantities of water and a comparatively low temperature in the silage favors the formation of acids. If the fodder when placed in the silo is very green and succulent a larger proportion of acids than is desirable may result. Butyric fermentation is another form that is found to occur in the silo at relatively high temperatures and may proceed in the absence of air. It seems quite probable that this fact may help to explain the small degree of acid found in the silage when slow filling is practiced and the fodder is allowed to be-

come very hot before covering. The changes due to butyric fermentation, however, seem to be more destructive than those caused by the acid ferments.

Another class of destroying agents at work in the silo is the mould-fungi. These belong to the class of organisms that cause decomposition rather than fermentation. A white, fuzzy-like fungus growth feeds upon the plant tissues, and the silage in time settles into a pasty, rotten mass of little value as food. This condition is often seen near the sides of the silo and may extend to the interior if the air is not well excluded.

The losses which take place in siloing, as well as in the field-curing of corn fodder, have been quite extensively studied at the Wisconsin Experiment Station. The quantity of dry matter and of protein of corn placed in the silo and the quantity of the same materials actually taken out were both carefully estimated, and the results compared with the losses occurring in the field-curing of the same kind and condition of fodder. The results of these experiments are found in the table which follows:

OBSERVATIONS ON THE LOSSES IN FIELD CURING AND SILOING INDIAN CORN, AS MADE AT THE WISCONSIN EXPERIMENT STATION.

		FIELD CURED FODDER CORN.				SILOED FODDER CORN.			
		Green Fodder.	Cured Fodder.	Loss.		Green Fodder.	Silage.	Loss.	
		lbs.	lbs.	lbs.	per cent.	lbs.	lbs.	lbs.	per cent.
Average for 3 varieties, 1887–8, ...	Dry Matter, .	4,294	3,502	792	18.5	3,808	3,176	632	16.6
	Crude Protein,	352	289	63	17.9	284	224	60	21.1
Average for 9 varieties, 1889, ...	Dry Matter, .	14,906	11,979	2,927	19.6	12,781	10,040	2,741	21.5
	Crude Protein,	1,172	905	266	22.8	1,024	876	158	15.4
Average for 2 varieties, 1890, ...	Dry Matter, .	32,432	23,270	9,162	28.3	32,432	29,090	3,342	10.3
	Crude Protein,	2,580	1,682	898	34.8	2,580	2,557	323	12.5
Result of 4 years' work, ...	Dry Matter, .	72,164	54,937	17,227	23.8	68,034	57,411	10,623	15.6
	Crude Protein,	5,706	4,317	1,388	24.3	5,490	4,569	921	16.8

The losses which occur in field curing necessarily depend largely upon the weather conditions existing, and to quite an extent upon the care used in stooking or shocking. The losses resulting in the silo, as has already been indicated, are due to a great variety of causes. As shown by these experiments, the size of the silo regulates to quite a degree the proportional losses occurring in the process of siloing. In the earlier experiments reported from Wisconsin the silos used were comparatively small and the losses of both dry matter and protein were relatively large. In 1890 a much larger silo was used, and it will be noticed that only ten to twelve per cent. of the dry matter and protein were actually lost. The results of four years work with a great variety of silage corns, with varying condition of weather to affect the field-curing, and with both large and small silos, show an average loss of about sixteen per cent. of both dry matter and protein in the case of the silo and about twenty-four per cent. of both of these constituents from the same kind and condition of fodder when field-cured.

COMPOSITION AND DIGESTIBILITY.

The food value of silage, like all other fodder materials, depends upon the amount and the relative proportion of its chemical constituents, and upon their digestibility. Silage made from corn is relatively deficient in protein or the muscle-making materials and contains an excess of the starchy materials, or the so-called heat producers. Silage made from the legumes contains nearly twice as much protein as that made from corn, while that of the legumes contains much less of the heat-producing materials. This gives the silage made from clover, soy beans, cow peas, or oats and peas a much higher feeding value as shown by its actual composition. While there seems to be no very marked difference in the digestibility of the two classes of silage taken as a whole, yet the protein of the legumes, as far as the experiments thus far made tend to indicate, is more thoroughly digested than the protein of corn.

COMPOSITION AND DIGESTIBILITY OF SILAGE FODDERS (GREEN) AND OF SILAGE.

KIND OF FODDER.	No. of Experiments.	PER CENT. IN DRY MATTER.				
		Protein.	Fat.	Nit. free Extract.	Fiber.	Ash.
Fodder corn for silage,...........	38	8.7	3.8	54.3	27.7	5.3
Sweet corn fodder (green),........	6	9.0	3.2	62.2	20.0	5.7
Corn fodder, field cured,.........	35	7.8	2.8	60.0	24.7	4.7
Corn stover, field cured,..........	60	6.4	1.7	53.2	33.0	5.7
Corn silage,.....................	102	8.1	3.8	53.0	28.5	10.0
Soy bean silage,.................	4	13.6	4.5	35.7	32.7	13.5
Cow pea silage,..................	4	14.3	2.9	45.8	27.0	10.0
Clover silage,......	5	14.9	4.1	41.7	29.9	9.3
Cow pea fodder (green),..........	2	15.4	4.2	50.9	17.3	11.2
Soy bean fodder (green),....... ..	5	16.7	3.9	43.4	25.7	10.4
Oat and pea fodder (green),......	2	20.6	6.1	39.2	23.7	10.4
Clover hay,.....................	38	14.5	3.9	45.2	29.1	7.3
Timothy hay,....................	68	6.8	2.9	51.7	33.5	5.1

PERCENTAGES OF DIGESTIBILITY.

Fodder corn (green),............	13	53	76	74	52	..
Sweet corn fodder (green),........	6	62	79	79	60	50
Dent corn fodder, field cured,....	21	52	75	71	65	..
Corn stover, field cured,..........	4	52	52	64	67	.45
Corn silage, ...	17	49	82	68	63	32
Cow pea silage,..................	4	58	53	73	52	30
Soy bean silage, ...	4	55	49	51	43	28
Cow pea fodder (green),..........	2	74	59	84	58	24
Soy bean fodder (green),.........	4	74	54	73	46	14
Oat and pea fodder,........	2	82	74	66	58	31
Clover hay,......................	7	52	48	60	47	37
Timothy hay,....................	12	49	57	54	56	37

FEEDING SILAGE.

The feeding of silage must be largely regulated by the judgment of the feeder, with due consideration for the kind of animal to be fed, and the kind of product for which the feeder is working. No hard and fast rules can be laid down as applying to the feeding of any class of animals. Silage can be advantageously fed to both dairy and beef cattle, and to sheep, and has been used to a limited extent in feeding horses, although not with marked success. In all cases where the fodder is to be fed to dairy animals, nothing except bright, wholesome

silage should be used. Where mouldy or decaying silage is fed to milch cows bad results may be expected in the milk. Owing to the large proportion of starchy materials and the relatively small quantities of protein found in corn silage, it forms a one-sided ration, unless fed with some of the nitrogenous grain feeds. Corn silage, hay, corn meal, and wheat bran cannot be compounded into a well-balanced ration. A fair proportion of either cotton-seed, linseed, or gluten meals, or perhaps better, a small amount of each of these should be used with corn silage to get the best results. There is some evidence that where corn silage is heavily fed the flavor of the milk is sometimes affected. When pure, wholesome silage, free from mould, is used, and in quantities not to exceed thirty-five pounds per day to animals of 800 to 1,000 pounds, live weight, no injurious results will be observed in the milk.

The silo is rapidly growing in favor as a means of providing succulent food for the dairy herd for the entire year. It is coming into use as a substitute for soiling during the summer months, and for this purpose has several advantages. With the silo the fodder can all be hauled and stored within a few days, and thus be more economically handled. The crop to be used can also be harvested in that stage of growth when it contains the largest amount of the best quality of fodder. In soiling much of the fodder must often be cut in an immature condition or else allowed to become over-ripe. As a means of guarding against the effects of drouth during the pasturing season, the silo becomes a very valuable adjunct to the dairy farm.

ECONOMY OF THE SILO.

That the use of the silo is the most economical method for storing and preserving the corn crop has been clearly demonstrated, and upon this basis the chief merits of the silo must rest. Corn is, and no doubt will remain, the leading forage plant of America. Its greater economy as compared with the better grades of hay for use in feeding dairy animals is now generally acknowledged. The better market grades of hay, such as timothy and red-top, are usually more economical to sell than to feed to the dairy herd. The less salable grades of hay can be fed to good advantage in connection with silage, as a certain proportion of these dry, bulky fodders are a benefit to the animal. As a matter of economy in the storage of

fodders the silo has several advantages. (1) More fodder can be stored in a given space than by any other method now in use. (2) The grain, stalks, and leaves are generally all packed in the silo together, and thus are fed together, saving a considerable expense for husking and grinding the grain. (3) More cattle can be kept on a given area of land when silage is largely depended upon than in the old system of using dried fodders. (4) The farmer may also be largely independent of weather conditions in harvesting his fodders. Crops of clover, for example, may often be stored in the silo with good results, when field-curing would be practically impossible. (5) It also supplies the herd with an abundance of succulent food at that season of the year when it could not be as economically provided by any other means. According to the testimony of scores of the best of our dairy farmers, the silo is next to a necessity in modern dairying. It has come to stay, and its real merits are being better understood and appreciated year by year. We have yet to learn of a farmer who has given the silo a thorough and systematic trial who is prepared to reject it and go back to the old system. The use of the silo is on the increase, and its merits will continue to be discussed until dairy farmers throughout our entire land have been made acquainted with its advantages.

(Music.)

Mr. Hammond. There is now an opportunity for any one to ask questions on this subject. We hope there will be a lively discussion.

Mr. ———. I would like to ask Prof. Phelps the probable cost per ton of the round silo that he spoke of, the barrel-like form?

Prof. Phelps. I am afraid I cannot answer the question. I have no figures on that from my experience. I know in the report made in the Farmers' Bulletin of the Department of Agriculture, there are a good many figures on the comparative cost per tonnage of silos, and the figures were decidedly in favor of the round form of silo; and I feel confident that the round form, made of staves, is fully as economical as any other of the forms.

Mr. ———. Is it the idea that these round silos are to be put outdoors without any other covering, or should they be enclosed? They should have a roof over, of course. Also, what shape should they be built? What is the convenience for getting material out? How are the doors arranged, and kept tight?

Prof. Phelps. I have said that with the stave silo, in this climate, it would not be wise to depend on it without an additional covering. A cheap form of covering, with protection of leaves or sawdust, would keep out the frost, and the silage would be kept in better condition. In one of the best silos I have seen, in the state, about half of the silo is below ground, and it opens right out from the end of the stable; but this silo is not made of wood, but was made of second-hand curved brick, obtained from an old railroad roundhouse. A young farmer bought them at a comparatively small cost, and built himself a silo twenty feet in diameter and nearly thirty feet deep, and the doors open into it from the end of the barn, so that most of the silage has to be elevated rather than to be lowered. Of course, if the silo is largely above ground, the fodder must be elevated and put in at the top. As to the doors, with the small amount of curve there is — in other words, owing to the size of the circle, it is not a very difficult matter to make the doors on the same curve as the rest of the structure, so that they conform and fit tightly.

Mr. ———. You stated that twenty-five pounds was a fair ration for a cow. Is that to be for one time, or three times a day?

Prof. Phelps. I think I stated about thirty pounds was a fair ration for a cow, and I should feed that twice a day, rather than at once. The exact amount it would be advisable to feed must be regulated, to a certain extent, by the amount of water in the silage, because the actual food materials to be given to your animals must depend on the amount of water in the fodders.

Mr. ———. Have you taken any pains to ascertain whether there are any more silos in Connecticut than five years ago?

Prof. Phelps. I cannot give statistics, but I am strongly in the belief that they are on the increase. As I travel about the State I hear of new ones every season, and that naturally leads me to think that they are decidedly on the increase.

Mr. Hoyt. We have had two silos burned, and we are sure to have silos put in every time. Have you ascertained the difference, whether cattle fed on ensilage will give as much milk as when they go to grass in the summer? What is the difference in the two results of the two kinds of feed?

Prof. Phelps. Do you mean when fed on silage during the summer season as a substitute for grass? I think every farmer, and nearly every scientific man I have talked with, will acknowledge that there is no possible substitute for short, fresh green grass in its actual value in the dairy for the production of milk.

Mr. Hoyt. I think cows will do better in good pasture from the middle of May until October on grass, without any grain, than on ensilage with a good deal of grain with it. Ensilage, I think, is better than dry stalks or hay; and it is much more convenient to store it. They claimed years ago it was better than grass, but it is not so. There is nothing which I have seen that would take the place of good fresh grass.

Mr. Gold. When Mr. Hoyt's barns were burned, were his pits full of ensilage, and was that burned?

Mr. Hoyt. Our fires occurred when they were empty, one in the spring, after we got through feeding, and the other in the month of August; but, mind you, after the August fire, we got built up soon enough to get the ensilage in.

Prof. Phelps. I would like to reinforce a little what I said in my paper of extravagant claims. One of the great drawbacks to the introduction of the silo has been extravagant claims made for it by over-enthusiasts and by men interested

in selling agricultural machinery, cutters, and ensilage corn. Those things have been a drawback to the introduction of the silo, because practical men have seen that these claims were over-stated and over-estimated. I think we have come right back on to the basis of economy in discussing the merits of the silo, not that silage is so much superior to other classes of feeds, not that it is going to prove a panacea for all the ills of dairying, but it is one of the cheapest sources of coarse fodders for dairy herds.

Mr. ———. I would like to inquire of the professor if sweet corn has any peculiar value over other varieties of corn for silage?

Prof. Phelps. I think it does have, not from the fact that it is sweet corn so much as from the fact that it does contain a larger percentage of protein; and another thing, animals seem to like it better; and I believe some of our larger varieties of sweet corn could be grown for silage just as or more successfully than the varieties of flint corn we grow to-day. The percentage of protein in sweet corn is larger, and the digestibility is also greater than that of flint corn fed under similar conditions.

Mr. Sherman. Do you consider corn put in as ensilage an improvement over the dry fodder for feeding purposes?

Prof. Phelps. As I stated in my paper, you cannot store the corn fodder in the silo without its undergoing loss. Whether a certain amount of dry matter in the form of silage, as it comes from the silo, is more valuable than an equal amount of dry matter of corn fodder, field-cured, is an entirely different question. Several things we have to take into consideration in feeding, and some of these are questions beyond the actual composition. There is the question of palatability and succulency of the fodder, which causes the animal to like or dislike it. I think the silage has an advantage in that respect; animals like it better, and do eat more of it, and I think they will thrive better on a given amount in the form of dry silage than in the form of field-cured fodder.

Mr. ———. In regard to silos of the barrel-stave kind, does the material all have to go in or out over the top?

Prof. Phelps. Not necessarily. There can be openings on the side. Those openings have to be built on the same general circle as the rest of the silo is. The door, of course, is not one continuous door from top to bottom, but a series of doors, with a tight section between, so that really you have openings extending from the top to the bottom, with the exception of narrow sections between the small doors.

Mr. Gold. I am situated where grass is a natural product, and we get that and hay cheaper than almost any other feed. It is very rare we do not have abundant feed. It is only for the last two or three years that we have suffered from lack of all the hay we wanted to use, and some to waste, but no great market for it; therefore the high price that hay brings in the market makes very little difference to us, and still we have introduced the silo. We find that moderate feeding of silage increases the flow of milk, and improves the quality, also the health of the cattle. We are all right there. But our mowing lands surround our barns. Our farm was laid out, and buildings constructed, for the purpose of having grass, and caring for it in the most economical manner. I don't know any farm where you can fill the barns with hay cheaper than I can. When I raise silage I have to draw my manure beyond the grass ground to the fields I plow, and they are pretty tough to plow. A good pair of oxen would not plow an acre a day, by any means. And the labor of drawing the manure is great; and when we have cultivated this crop, as we have to do to keep down the weeds, with a cultivator, and sometimes with a hand hoe, and then cut the silage and draw it to the barn, we cannot get our fodder for our cows as cheap as we get it from our mowing fields, so conveniently located around the barns. I have kept account of the labor for years it has cost me to get the hay crop (I kept a rather loose account with the silage business last year, and I had a fine crop), yet I don't believe it

will keep the cows as cheap as the hay. Still, I propose to follow it up, for this year it formed a very important addition to my winter fodder. I should have had to reduce my dairy very materially; but I put in about twenty-five acres of sowed corn, and half of that we put in the silo; the rest of it was fed green or cured in the stock. But as to the great argument that it is so economical, you must consider the circumstances; you must have level land near your barn that has got to be plowed in order to get a crop, and no great distance to transport your manure, and no great distance to transport the heavy corn in the green state, where plowing and cultivation is easy compared with work on our turf-bound hills. I think some of you had better consider your situation before you rush into the idea that there is such a vast economy in the silo, although I am in favor of it as supplementing our other resources.

Mr. Hammond. I would like to ask the secretary if he does not have to plow his grass lands to keep them up?

Mr. Gold. They have been mowed 150 years, most of them, and the crop varies up and down somewhat according to the season; but their average for the last twenty years is greater than it was fifty years ago, nearly two tons to the acre. We think we have got something there that will stand by us. If grass fails us we do not know where we shall go.

Mr. Brown. You call that permanent grass land?

Mr. Gold. Yes, sir.

Mr. Fenn. At the meeting of the State Board of Agriculture at Great Barrington three or four years ago, Governor Hoard was present and made the statement that the silo had been a God-send to many of the Wisconsin farmers. Governor Hoard was buying milk to the extent of supplying 4,000 customers with butter in Chicago, at fancy prices. Prof. Phelps has made the statement that condensed milk factories and some others objected to the feeding of silage, on account of the flavor it may give the milk or butter.

Mr. Gold. In regard to the Borden's Milk Factory con-

demning the use of silage, we live on the borders of the district from which they draw their supplies, and have been familiar with their work. It is true that Mr. Borden prohibited the use of silage at their Wassaic factory, as there were complaints made about some of the milk in the market and the trouble was attributed to the silage. He prohibited the use of the food, and furnished grain free to the farmers to make up for the loss of the silage that they had in store. But it was afterwards discovered that the bad milk did not come from the factory there; that it was at another factory connected with the same firm, and was traced to the water which they used, rather than to the silage at all. But I believe that the rule has not been revoked at Wassaic in regard to the silage. There was a disposition to feed it extravagantly there among some of the farmers, their conditions being very favorable for its use.

Mr. Stadtmuller. In the matter of silos, as about everything else, when you come to simmer it down, it is simply a question of economy in relation to the general line of work undertaken by any one. Broadly stated, silos at present, within the State of Connecticut, are only practical probably where extensively used. Speaking of the remarks of Mr. Fenn, about Governor Hoard's statement, it illustrates the point perfectly of the conditions. I believe the secretary is perfectly sound and right. According to his conditions he says it is not profitable to make silage on his farm. Now in regard to Governor Hoard's statement, that silos and separators have paid many of the mortgages of the farmers West, it remains to recognize the fact that it costs about one-fourth as much to produce a corn crop in Wisconsin as it does in Connecticut. That is why silos in Wisconsin are able, with separators, to raise the farm mortgages.

Mr. Fenn. Speaking of the matter of economy, reminds me of a circumstance where I attended a meeting of the Massachusetts board at Greenfield, and on the way home I had to wait over in Springfield for the train; and in conversation with

a man there, he stated that a man had sixty-five acres, sixty of which were in corn this year. He had two large silos, and filled those, and built two more, and still had twenty acres left to stook, and expected to feed dry fodder as well as silage. That man must have looked at it from the point of economy, surely. If I understood the gentleman correctly, he fed it 365 days in the year to make milk for the Springfield market. He must consider the silage a matter of economy, I should think.

Mr. ———. I am pretty well satisfied if that man had good pasture he could make milk cheaper with grass. I would like to ask Mr. Gold if there is any waste in the corners?

Mr. Gold. I am sorry to say there has been more or less waste, especially from an experiment this year. We supposed we had got the silo about full, and the engine broke down, and I gave orders to put it in whole, and we put it in whole, and kept at it until finally we got it full; and there is a good deal of waste in such kind of stalks as I had. My corn was, a good deal of it, fifteen feet high, some of the mammoth corn; and to pack that so that it would settle perfectly even was impossible, and to get it out is a hard job.

Mr. Hoyt. How do you get it out, anyway?

Mr. Gold. Begin by cutting with a hay-knife on top. They said it was reasonably soft. When they get down further it takes an ax to cut it. We have not yet got down to where the cut silage is.

Prof. Phelps. I want to say a word in regard to Mr. Gold's statements. Of course, we must consider that every farmer, in his operations, must be regulated by his conditions. Now I agree with Mr. Gold fully, that under his conditions the hay crop is cheaper for him to feed than silage, because he has no market for hay, except pressed and shipped, a very expensive process for him. He has a very good home market, the best kind of a market. There may be many other farmers under similar conditions in the State of Connecticut, where the best

use they can possibly make of their hay crop is to feed it out on the farm. Under those conditions we should expect that the hay would be a cheaper grade of food than silage. But there are hundreds of farms throughout the State of Connecticut located near good markets for hay; and I hold very strongly that under those conditions silage made from corn is a much more economical feed.

Mr. Fenn. I would like to ask the secretary if he would consider it economical feed to feed hay at one cent a pound to make milk at two and one-half cents a quart? That is about the price of hay in my market.

Mr. Gold. I tried to be understood. I said circumstances and locations altered cases, and that we wanted to have a kind of "experience meeting" from our own standpoint; and I said, too, that I approved of the silo, and wanted to use it as a supplementary part of my farming operations; but that I could not accept, in my case, the very great economy, the saving, there was in substituting silage for hay and grass on the farm. That is the only point, gentlemen. You understand me, I believe.

Mr. Hoyt. This question seems to be one of almost as much interest to farmers as the stable manure question, and it is one I think about as much of as I do of that, though I think it is a means by which the farmer can lengthen out his food for cattle. You can put on your bran and cotton seed meal and with it make a full ration for your stock. Where you can sell your hay, as in Fairfield County, for $15 to $20 a ton, and buy wheat bran for from $10 to $15 a ton, we think it more profitable to use bran. But ensilage, so far as I have observed it, is awfully offensive, mean stuff to handle, and one who goes into the barn to feed it, he needs a rig to put on when he goes in, and take it off when he comes out, and it would be a good thing if he had two wigs, one to wear when he went in, and another to wear when he got out. There is more or less decomposition, and there is more or less offensive smell to it. I have heard of

"sweet" ensilage, but I never saw it. With us we must have silage, so much of our farm is in the nursery; we have little hay, and keep twenty horses and thirty cattle, and have waste land to pasture, and want to keep them through the winter, and the result is we are short of hay, and we use ensilage for the cows, and it enables us to carry our stock through, and many times sell fifty tons of hay, sometimes less. Ensilage is cheaper than to buy hay. When we go to the silos, we call off the men to the work. We put in half a dozen or more men to cut it, and we run in fifty tons a day, cut it up with steam power, and we put in 300 tons in a week. We have a neighbor who has one man. He gets power to come there, and he has to call in his neighbors to help put it in. It is a heavy process, and takes labor to handle, and when he has to hire labor to handle it, he realizes what it costs to put ensilage in. It is like carting stable manure; it is water, wet. You can handle the dry fodder cheaper; and the shredding machines they have now, I think, will put cornstalks in condition for cattle to eat, and if ground feed is put on this shredded fodder, they will eat it up clean.

The secretary announced a telegram from Mr. Simonds that he could not be present from temporary illness, but would send his paper to be read in the evening.

(Music.)

At 4:45, recess was taken until 7:30 P. M.

EVENING SESSION.

December 16, 1896.

(Music.)

Mr. Brown. Gentlemen, I have the pleasure of introducing to you this evening the Hon. Samuel A. Chalker, member of the Board of Agriculture from Middlesex County, who will preside at our meeting this evening.

Mr. Chalker. Ladies and gentlemen, our worthy secretary has his Question Box somewhat loaded up, and we want to make room for more questions; therefore we will open that the first thing.

Mr. Gold. "Will cows do as well, and give as much milk, kept in the yard in the summer, and fed on grass or clover cut for them, as they will with the run of good pasture?"

Some of our dairymen here are the men to answer that question. Mr. James Hoyt ought to be able to tell us.

Mr. James Hoyt. We never have had any experience in that line. When the grass is large enough for pasture the fore part of May we turn our cows out, and are not obliged to feed them in the yard.

Mr. Brown. My own experience is this. I am fortunately situated so I have two pastures, a large pasture some distance from the house, extending half a mile from the house, though the entrance to it is less than a quarter of a mile. That my cows have the run of during the day. At night they have a smaller pasture, though there are at least thirty or forty acres in it, that they have the run of at night; and between the two we do a great deal better than we would to let them have the whole, and yard and feed them at night. I am satisfied that there is not anything better for cows at night than a good pasture, especially when we are afflicted, as we have been of late years, with the Texas fly. They suffer much worse from them in the barn than in the pasture.

Mr. Gold. This question supposes they are kept in the yard all the time and fed with grass. That is worse and worse, isn't it?

Mr. Brown. Yes, sir. I think they would do much better to have the run of a good pasture.

Mr. Gold. "Are American persimmons hardy in this latitude?"

Prof. Gulley. I should say yes, so far as the trees are concerned. There is no reason why the trees should not be hardy.

I know they will live out doors very readily all winter. As to being profitable, that is another thing.

Prof. Britton. A few trees may be found growing wild at Lighthouse Point, at New Haven. I never saw any fruit on them, and don't know about that. I have not seen them in cultivation.

Rev. Mr. Meech (Vineland, N. J.) This gentleman says they have trees growing, but do not bear fruit. It is the male tree that does not bear any fruit. There is as much variety in them as in the variety of apples shown on your tables here. Some of them are as small as grapes, some of them quite large, and there is a difference in their time of ripening. They have a commercial value when you get as far south as New Jersey. There people gather and send them to the cities, and find a market for them.

Mr. Gold. "What is the best time for seeding to grass; spring or fall?"

Mr. Hale. Mid-summer; August.

Mr. Hubbard. Fall of the year.

Mr. ———. It depends on whether you want to seed for grass alone, or seed for other crops.

Mr. Hale. Did not the question imply that you want to seed for grass? If it is grass you are after, you don't want to seed for anything else.

Mr. Sherwood. I sowed a piece to grass after White Onions, about the 23d of August, and I got a crop of hay from it the next season.

Mr. Gold. If you are to seed with grain crops, barley is the best crop to seed with. Spring wheat is a very favorable crop also to seed with, much better than oats or any other spring grain. If you are to seed to grass alone, I think that your success might be best in the spring, or along in late mid-summer, when we expect fall rains to keep things alive. That would be about the time Mr. Hale and Mr. Hubbard would seed for grass.

Mr. Hoyt. I was at Amherst College last season and interested in looking at meadow ground there — I should judge there were two tons to the acre, at least. The seed was sowed with the corn, last hoeing, and in the fall the field was rolled so as to smash down the stalks; and when I was there in July the grass was immense.

Mr. Gold. "Can butter made from separator cream be properly called dairy butter?" Why not? What should it be called? Is there any reason why it should not be called dairy butter? Is not it a legitimate butter process to make butter from cream raised with a separator?

Mr. Hinman. The query was put, possibly, as to whether it was creamery butter or dairy butter, as we have those two products in the market.

Mr. Gold. "Does it encourage the development of Apple Maggots" (that is, the apple railroad worm, as we were instructed to-day), the *Tripeta pomocella,* "by spreading apple pomace in the orchard?" Let's hear from some of our scientific men, who know about this species of vermin. How does it affect them to go through the cider mill?

Professor of pomology, let us hear your opinion. How much will they stand?

Prof. Britton. It is rather difficult to say. I do not think the maggots themselves would stand much pressing, while if the apples were not finely ground they might go through and come out alive; but the chances are that most of them would be killed in the process.

Mr. Hoyt. I should think that process of grinding would destroy them.

Mr. Gold. "What fruits for family use should be planted on city lot 50x150 feet in dimensions?"

Mr. Hale. I should think the stocking would depend a good deal on what the family liked. Some would put it nearly all to grapes. Others would fill it full of pear trees. Occasionally they will have all the pears they want, and a sur-

plus to give away. Again, it would depend on the soil, what fruits might grow there; but I know of city lots not much larger than that, where there is a good variety of grapes, and apples, and pears, and peaches, and all the small fruits; but it takes a man that has a love for them, and knows how to do it. Without knowing the local conditions, I don't think any one could answer that question to match every city lot. I should want to see the fellow first, and perhaps his wife and daughters.

Rev. Mr. Meech (Vineland, N. J.). Brother Hale left out the quince tree. A brother clergyman came down to Vineland and had a couple of trees planted, and said afterwards that his family got all they wanted from them.

Mr. Gold. "What is the best way to destroy currant worms?" Anything better than Hellebore?

Prof. Gulley. Yes, sir; Paris green is much better. The man who puts on Paris green thoroughly once, as soon as the plants are beginning to blossom, and follows it up the second time, if he don't have too much rain, he will kill them. You might put it on the currant, any ordinary dose of Paris green, and eat the currant, and not hurt yourself.

Mr. Gold. I should a little rather have my currants from bushes which had not been treated with Paris green. I am prejudiced against it.

Mr. Hoyt. Hellebore is just as effectual as anything you can have. It is death to them. One dose will kill them. Dust it on when the dew is on.

Mr. Gold. "What is the best remedy for the Elm Tree Beetle? And are their ravages likely to continue for all time to come?"

Mr. Hoyt. There is nothing short of spraying them with Paris green, I think.

Mr. Hubbard. That Elm Tree Beetle is a tremendous menace to our noblest shade trees. Spraying has been tried. Has it been successful? And is it practicable in country districts? I have some noble elm trees in front of my house, and

the beetle is within three miles of them, and I hardly know what to do about it. It seems to me a very serious matter, and I almost fear that it will compel us to abandon the common use of the elm as a shade tree. I wish if there is any section where really effectual means have been tried we might learn what they are.

Mr. Brown. A year ago last summer the elms on the parks in Hartford were stripped, and again when the second growth came out, and the elm tree I set out in front of my house was served in the same way. This season Hartford city spent quite large sums of money in spraying their trees — had a two-horse wagon, fitted up with pumps and steam engine. They sprayed their trees thoroughly with Paris green and lime, and it proved to be exceedingly effective. I did not see a bug on their trees, or one on my tree forty miles away.

Mr. Gold. That, to a certain extent, covers the last clause, "Are their ravages likely to continue for all time to come?" We have had strong hopes that the plague would be stayed, but just how far it has been stayed this present year I don't know. This is the first positive case that has come to my knowledge. I should like to hear of more of that kind.

Mr. Platt (Cheshire). I think we have had them in Cheshire about as long as any town in Connecticut. I think we have had them five years. They are very voracious, and have eaten our trees badly. The only thing we have done to try to destroy them was, in 1895 we killed the beetles after they had crawled down from the tree, when they were on the trunks near the ground. The past season they were not so plentiful. We are losing our trees rapidly. They are taking down four of the very largest from our church green — as large as the elm tree ever grows.

Mr. Gold. Have the Experiment Stations any facts to give us?

Mr. Birge. In the town of Southport they have ruined many of our trees; but last year there were not as many of

them. "Every dog has his day," and I presume they will have had their day. I believe the trees now living will live.

Mr. ————. I would like to know how long they have been working in the western part of Connecticut. In the eastern part I think they are almost wholly unknown. I would like to ask Mr. Hinman what caused the appearance of the foliage at Hartford last season; whether it was the effect of the spraying, or the beetle? It was of a peculiar reddish hue. Was it the effect of the spraying?

Mr. Hinman. I do not know about that. There were none of the trees stripped of the leaves. Some of them said there was a time when there were a few beetles on them. There was no serious injury to the trees in Hartford that I know of. None on the Park, especially. Elm trees along the Housatonic River, within a few miles of me, had beetles on this year. My own had none that I could find. I looked carefully on the trees in Hartford when they said there were beetles there, but I could not find any. A year ago trees within a mile or two of me showed signs of the beetle.

Mr. Hoyt. They are diminishing, I think. Their work was not as serious last year. When they got through, what few there were, we did not find that quantity coming down to the base of the tree we have usually seen. I feel greatly encouraged.

Prof. Britton. When Prof. Howard, of Washington, visited this State last spring, he expressed the opinion that the Elm Tree Beetle would be less abundant during the summer of 1896, than it was in 1895; and probably it was; yet it was not very greatly lessened in numbers. In New Haven many of the trees were sprayed last season, and I think the spraying was fairly effectual, but it was not done perfectly in all cases. Occasionally a tree would be noticed where the foliage had been greatly injured by the insect. I do not see any reason why the insect should be greatly lessened, except through its natural parasites. And I doubt if the spraying is feasible in

the rural districts. In large cities, of course, it can be done, and I think it should be done, to protect the trees. Through the country districts, where there is here and there an elm, possibly it is much harder to go all about and spray them; and there it should be done by the owners of the trees, if they wish to preserve the foliage. I don't think all the elms can be sprayed in this way.

Mr. Gold. "Please explain the mission of the Dragon Fly?"

Prof. Britton. There is one here in the case. Some people imagine it is an injurious insect. Far from it. It is one of our beneficial insects, and one we ought to encourage, and not kill. It helps us by devouring the larvae, or maggot form, of the mosquito, which breeds in stagnant pools all over the country — feeds largely on the larvae; that is its mission.

Mr. Gold. "Give us some information as to the amount of adulterated spices, molasses, coffee, etc., probably on the market, from which samples are shown."

Prof. Winton. That is a very difficult question to answer. I might say, all that people want to buy. All we have money to spend for. The Legislature at the last session gave our station the munificent sum of $2,500, with which we are to hire inspectors, and go about the State and gather foods, examine them at the laboratory in New Haven, and get out a report to the Governor, send reports to the prosecuting attorney, etc. We bought with the $2,500 all the foods we could afford to, and there are plenty of adulterated foods left. This work has been carried on with vigor during the last year. The law went into effect last fall, and since that time we have examined something like 1,000 foods collected in the open market, and have found several hundred cases of adulteration. Our first report was made about mid-summer, I think, along in July — and in that we published about 250 samples of foods examined and found adulterated. The foods examined were coffees, lard, maple syrup, honey, pepper, mustard, cream of tartar, and milk; and since then we have examined samples of

olive oil, and various food products to which artificial chemical preservatives have been added. We would say we have detected an immense amount of adulteration. Ground coffee we found extensively adulterated with the Canada pea we hear so much about as a valuable agricultural plant — valuable in other ways. These coffees are adulterated with the peas roasted and crushed so they do not resemble the pea any more than something else. Artificial coffee made out of wheat middlings, so that it takes a sharp eye to detect it from real ground coffee. In addition also we found little pellets made up from pea hulls. These are made into a paste with flour and water and make another good imitation of coffee. Of course we find chicory. In some samples only 30 per cent. of real coffee was found. One sample we found had only 32 per cent. of real coffee. You know real coffee can be bought in the retail market for 35 cents a pound. This sample contained one-third its weight in coffee. At the rate of 35 cents a pound it contained about 12 cents' worth of coffee. I would not say the retailer made that difference, but they both made more than they would with honest goods, and a great deal of this money was used up in paying for worthless materials the coffee contained, and also paid for the trouble of manipulating them.

In addition to the coffee, we found lard is extensively adulterated — the compound lard that is sold. In the case there you will see a sample. While pure lard contains 100 per cent. of hog fat, this contains from 20 per cent. down to nothing. It consists of cotton seed oil and beef stearin. Stearin, a by-product of oleomargarine, is mixed with cotton seed oil and makes the compound lard. When sold under a suitable name some people like it. I do not like it, but those that want it can have it. It is a strange fact that these dealers have a way of selling it for lard, and do not give the consumer a chance to decide whether he would prefer this mixture, or the other lard.

Spices are adulterated with almost everything. If you can mention anything that can be used that is not, I would like to know it. Cocoanut shells are used ground up, and in that condition resemble allspice. Roast cocoanut shells a little, and you get a black pepper. Buckwheat hulls make a pepper we find extensively on sale in the market. I wish to have you know that the buckwheat kernel, like the hog, is used "from snout to tail." They use these outer hulls for black pepper, and then the inner side coats of the buckwheat make very nice white pepper. Mix a little red pepper with them each time. You will notice that I have spoken of red pepper as an adulterant. It is also sold under its legitimate name, but it is largely adulterated. Buckwheat middlings and rice flour, when properly colored with aniline dye, make very good red pepper.

These facts I have mentioned refer to foods on sale in our market. I am not talking about what has been sold in England, way back fifty or sixty years ago, but just the things sold in our market. If you will look in the case here you will notice some other strange things. Cream of tartar. I had better stop, or you will not believe me.

Mr. Hale. This is all interesting and true, but I struck something quite refreshing in an opposite line in some of the Southern markets. It was offered and plainly placarded: "Lard. Warranted not adulterated with hog's grease."

Mr. Gold. At this time I wish Dr. Sturgis would explain a few other things from the Station.

Dr. Sturgis. There are some photographs. One is of the so-called new disease of asparagus, shown also by dried specimens on the paper pasted to the right of the Experiment Station case. That was first called to the attention of the public by letter of Prof. Halstead, who said it had suddenly become very prominent in New Jersey, and was doing a great deal of damage to the plants. He wrote me a letter and asked if I had heard of it, and I wrote and said I knew the fungus, but

had not heard of it as a destructive disease of asparagus. The next day I thought I might as well go out and look at our own asparagus bed at the station, and I found it teeming with the same disease. I then wrote to two or three others in the State, and they reported there was an immense amount on their bushes. I then recommended the burning of the bushes. That is the only possible cure for it, I suppose. It is likely to weaken the bushes, and thereby decrease the crop the next year, though I hardly think the fungus itself will attack the young shoots. It is one of those curious instances where a disease is known as a "new" disease. This was known many years ago, it was understood, and specimens examined by botanists with the microscope. The past year it sprang into prominence and became epidemic; so that it bids fair to become a very serious disease of asparagus, unless it is stamped out by burning.

Mr. Gold. We must defer the further consideration of the Question Box at present, for the regular exercises of the evening.

Mr. Chalker. We are sorry to inform the audience that we have been disappointed in our lecturer, Mr. Simonds, who was to have read a paper to us here to-night. We have learned by telegram that from temporary illness he is unable to be present. The Rev. Mr. DePue has kindly consented to read his paper at this time.

IN THE WOODS.

By Hon. Wm. E. Simonds, Hartford.

Your Secretary set before me two titles, from which I might choose one as the subject of a short paper to be read before you. "In the Woods" was one of them. I chose that because it is vast, illimitable, and because I know nothing about it from a scientific point of view. The extent of my lack of knowledge was doubtless well-known to your Secretary; and he, quite likely, was curious to see what a man would write concerning a subject about which he knows nothing.

Nevertheless, if I knew a great deal about it, I am by no means certain that I should undertake to appear before you with much in the way of facts and statistics, for, as I grow older I grow more and more mindful of the element of truth there is in the remark made by a free-speaking man to the effect that, "There are lies, confounded lies — and statistics."

The woods and I are great friends. We are great friends all the year round. In the early spring, when the earth is sodden and snow remains in patches, when little pools stand all about, and the arbutus announces the coming of a new heaven and a new earth, I have found myself greeting the woods with a welcome rising to a passion just as I have more than once greeted the brown earth in spring. A little later, when the pussies spring on the willows, the tassels on the alders, and the miracle of budding leaves is worked afresh upon the trees, I have found my pulses bounding "with all the fullness of the spring." What a wonderful world it is, when the apple blossoms are blown to the full and all the air is odorous with the perfume so illusive that no mystery of chemistry can catch and hold it. And if, then, one gives way to the Berseker in his blood and goes a fishing for trout and takes home a basket full as evening slowly hides the apple-blossoms — well, it's a thing to long remember. And later when the summer heat and the summer rains have covered the trees with leaves innumerable, when the greenery underfoot hides each square inch of earth, when the roses are splashing the lawns with glories of color and the rye and the tall grass are bending in billows under the summer wind, one may then, without effort, call to mind: "He maketh me to lie down in green pastures, and leadeth me beside the still waters."

Still later, when the fall frosts are come, when the corn stands shocked in the fields regnant over the golden globes of pumpkin; and the woods are all aflame with crimson, and amber, green, and gold,what is there in heaven above, or in the earth beneath, or in the waters under the earth, that can surpass them in beauty? And when, a few days later, "the flying gold of the ruined woodlands" drives "through the air," and the vast carpets of yellow leaves, rich with all the garnered sunshine of the summer, rustle underfoot, what a sense of nature's wealth surges in upon the soul.

And still later, when the snow covers the ground, littered here and there with the track of the rabbit and the squirrel, and

all the trees are bare, save the evergreens and the scrub oaks with their little banners of brown, how in their sturdy might the leafless trees break against the sky, and teach what strength and fortitude should, in us, stand behind all accomplishments. And who can forget the shining splendor of a New England ice storm, which loads each shrub, and twig, and tree, with crystals of diamond and amethyst, flashing with all the colors of the rainbow, and glittering as one may imagine the domes and minarets of heaven to glisten.

The woods can be very solemn and impressive. I have journeyed for days at a time in the Maine forests, with never a ray of the overhead sunshine glinting through from morning till night, with no small bird and no song bird near, and with an occasional partridge, so tame that one could touch him with a switch; in such circumstances the twilight and the hush brood so heavily on the spirit, that at last one emerges into the sunshine as into a deliverance. In those same Maine woods, I have stood on a mountain top, and swept the far horizon in all directions, only to see nothing but an unending billowy ocean of green forest; the sensation of immensity and of the power of the Creator of these vast living solitudes is something that cannot be described.

I have been among the gigantic red woods of the Mariposa Grove, with trunks of that diameter which permits a coach and four to be driven through a passway cut therein; I have realized that these were trees of great size when Christ walked upon the earth, and of fair size far back of that in the days of the shepherd kings of Egypt, before the palmy days of Egyptian civilization; and the realization of these facts gave a feeling of verity and reality to that historic lore, perhaps not possible to me in any other way.

The woods do not yield up their secrets to him who travels them with hasty step. One may walk through a forest which is fairly populous and get no glimpse of the inhabitants. But if he will sit quietly and patiently at the foot of a tree, the little people who have jackets of fur and feathers, the squirrels, the rabbits, the wood robins, and even the partridges, will steal out from their coverts, and allow themselves to be looked upon. They are quiet themselves and you must be quiet if you would have their company. And it is only in such quiet that one can feel the spirit of the woods. There is a spirit of the woods which will enter into the soul of him who woos

that spirit in quiet contemplation. It is a spirit favorable to meditation and to the generation of that philosophy, which will send one into the outer sunshine strengthened to bear the ills which fret and chafe all the way from the cradle to the grave.

Bryant, in his Thanatopsis, has described the soothing effect of nature upon the perturbed human spirit in perfect words:

> "To him who in the love of Nature holds
> Communion with her visible forms, she speaks
> A various language; for his gayer hours
> She has a voice of gladness, and a smile
> And eloquence of beauty, and she glides
> Into his darker musings, with a mild
> And healing sympathy, that steals away
> Their sharpness ere he is aware."

The so-called sportsman has a use for the woods which shows how deeply the savage lurks in our being. When the crisp October air sets the blood tingling in his veins, he straightway takes to the woods with dog and gun, that he may kill something. And men are not ashamed to describe their eager joy in the killing, and magazines which pride themselves on being the exponents of a high civilization are not ashamed to print a narrative of the delirious ectasy the hunter feels in shedding the blood of the harmless denizens of the woods, both great and small. Ah, well, we have progressed somewhat since we killed and ate each other. There is yet hope for us and for our furry and feathered brethren.

A tree is one of the infinite number of things which, to right reason, teach conclusively the immanent presence and power of God. It is the cunningest sort of a machine from rootlet to topmost twig. It is a vast labyrinth of conduits and valves, to the like of which man cannot approach. The tiny hairs on the rootlets select with unerring judgment the moisture and the minerals fitted to be transformed into that tree's particular kind of food. The little conduits carry them up the trunk, along the branches and twigs into the leaves; there the leaves part with the moisture in greater part, and, by the aid of the air and the sunshine, convert the crude materials into true tree food and — miracle of miracles — endow it with that mysterious quality, which we call life; then other cunning conduits carry this food back and down, and distribute it evenly and generally, when thus distributed, the tree substance

assimilates it by virtue of the affinity of the life principle between the two, and so we say the tree grows.

We look at the oak which has breasted a thousand storms; "sick at its stubborn hardihood," and to the eye it appears about as little alive as anything can be; nevertheless, it is wonderfully alive. A single well-developed oak has some seven hundred thousand leaves, and lifts from the earth into the air about one hundred and twenty-three tons of water during its five months of foliage. Try to appreciate what that means when applied to all the forests of the earth, and in doing it, try to appreciate the nature of the Power whose overlooking of this is one of the smallest incidents of His superintendence of the universe.

But the wonder of it pales before another wonder. You bury an acorn in the earth. Straightway, it becomes a soft putrescent mass, and just as it is seemingly given over wholly to rottenness, a tiny green point starts out from the decay, pushes its way to the surface of the earth, and in due time becomes a sturdy oak. This miracle is worked under our eyes a million times every year, but to the duly observant eye the wonder of it never fails. Saint Paul made it the text of the noblest words which ever fell from human lips: "But some man will say, how are the dead raised up? and with what body do they come? thou fool, that which thou sowest is not quickened except it die. And that which thou sowest, thou sowest not that body that shall be, but bare grain, it may chance of wheat, or of some other grain. But God giveth it a body as it hath pleased him, and to every seed his own body. . . So also is the resurrection of the dead. It is sown in corruption, it is raised in incorruption. It is sown in dishonor, it is raised in glory; it is sown in weakness, it is raised in power. It is sown a natural body, it is raised a spiritual body."

Even St. Paul cannot tell us the how of the doing of it. He only points us to the Doer. When it comes to telling us how it is that He "works in a mysterious way His wonders to perform," St. Paul leaves us where he found us, "In the Woods."

Mr. Hale. I do hope we are not going to adjourn without saying something about this charming gem from Mr. Simonds. I certainly want to express my great appreciation of the paper itself, and also of its presentation by our friend this evening.

It seems to me that papers of this kind, and thoughts of this kind, are all too rare in our meetings, and in our daily life, to be let drop without some consideration. While I was interested in every portion of it, the part that seemed to me most practical, that which he only hinted at in a way, but a very neat way, the destruction by the killing of birds under the name of "sport'" merits attention. Can't we in our home life teach our boys, and brothers, and fathers that destroying the life of the beautiful birds and other animals is not a sport at all, but something — I don't know as I care to put a name on it — but that we ought not to countenance it; a relic of the Dark Ages? Don't we wish these beautiful things to live and play among the trees, so that they may enjoy life, and we may enjoy life in our associations with them? We ought, at least, to think of these things.

Rev. Mr. DePeu. Mr. Chairman, I have been invited to repeat the suggestion made here at one side, *apropos* of the paper of Mr. Simonds — while he has carried us all with him in the portion of the paper Mr. Hale has alluded to, has also brought up the question, which I think is unassailable, of how it is possible for a man to be so sympathetic for the birds, and the squirrels, and so devoid of sympathy for the trout? I was interested in a talk last night I had with one gentleman who has left this evening, in which he was speaking of what he meant to do if he ever became a millionaire. He was going to fit himself out with a thousand acres of land, more or less — I have forgotten the amount — and let it grow up as nature would have it, and he was going to have streams in it, which he would have thoroughly stocked with trout; and he said, "I won't fish them out either." Some of you who know Mr. Simonds may put the question to him and get further light on the subject.

Mr. Hubbard. I wish I were able to speak on some phase of Mr. Simonds' paper as it deserves to be, but I feel I am hardly competent for any such task as that. There is, no

doubt, a peculiar influence which the woods have upon any susceptible nature. Association with the woods develops a peculiar phase of charácter. The woodman is different from the man who lives in the open. I am not a woodman myself; I believe in being more in the open; yet I have felt the influence which the woods have upon one; and I recall here one experience of mine, a very brief one, over in eastern Connecticut, in the good old town of Woodstock, being there upon some occasion, I hardly remember what — perhaps it was visiting the Agricultural Fair — and our good friend Dr. Bowen took me into his carriage and showed me something of Woodstock, of the eastern border of Woodstock Lake; he took me to the grounds of a wealthy New York physician — I think he had a summer home there, and he had located in the woods, purchasing and owning quite a large tract of land there entirely occupied with woods. He had a small cleared space, in which he erected a house; and his idea of the woods was, not that they were to be beautified, or laid out, or treated, or anything done with them, except just enough to enable the man who was in the woods to get around in the wood. If a tree fell it lay where it fell, and nature took care of it. If a tree started to grow, it grew as it could; nature took care of it. A portion of it was occupied by young pine forest. The new trees were started as thickly as they might, and were growing as they could, up sixty or seventy feet high, and you could only get around among them by little footpaths. And as you passed into that most dense pine forest, it seemed as if you went into another world. The sensation is indescribable; and I did not suppose there was a place in the State of Connecticut where such a forest as that existed. But our little State, although not a forest State, has some most wonderful situations, where one can find himself most thoroughly "in the woods," and if one is in sympathy with the influences of the woods, I believe it to be an experience worth while, now and then, even in spring or fall, in winter or summer, to go into the woods and commune with nature there.

Mr. Gold. Speaking of this fishing question, some one spoke to our beloved Senator Platt about his having been in the Adirondacks fishing. "Well," says he, "I don't fish much, but I love to sit in the woods by the brook." That was his happiness so far as the fishing went.

Mr. Hinman. Mr. Chairman, I have a resolution I would like to present.

Resolved, That we recognize in the Hon. Wm. D. Hoard of Wisconsin, a patriotic citizen, devoted to the agricultural interests of our country, with a practical knowledge of agriculture and its needs, and with executive ability adequate to the carrying out of measures for the advancement of the great industry in which we are engaged; and that we earnestly desire that he may be appointed to the responsible position of Secretary of Agriculture.

The object in presenting this resolution is simply that the farmers of Connecticut assembled here may let their wishes be known in this respect. Other States are doing that, and while we, engaged in other industries to a large extent, not entirely farming in a small State, cannot expect to dictate, cannot expect possibly to have the same weight, still it is entirely proper that we should let our wishes be known in the matter, and that we feel that the farmer of this country will possibly realize the necessity at this time more than they have heretofore, of saying something as to whom they will have to take care of their interests in Washington.

The Chairman. You hear the resolution; what is your pleasure in regard to it?

Mr. Hubbard. I would very gladly second the resolution. The only possible objection which can be raised, as it seems to me, to the passage of that resolution, might be raised to the consideration of it — that is, to the introduction of strictly political topics here, and I have placed myself in a position where I could not raise that objection. I do not think there is anything improper about it. There is no partisanship about

it. We know, of course, that the next Secretary of Agriculture will be a Republican. The choice is limited to that. And we know Governor Hoard. We have had him here among us. He is a Republican, but that does not cut any figure in our consideration of this matter. We have tasted of him and know his quality, we know his flavor, we know his substance, we know the rarity of him, his effectiveness, we believe him to be perfectly sound, we believe him to be true, and we believe him to be capable. I believe him, and think every one who has met him must coincide with me in this belief, one peculiarly and eminently fitted for the position named in that resolution. I very cordially second and support it.

Mr. Hale. As Mr. Hubbard has well said, we in Connecticut, and this Board of Agriculture, this convention of farmers, have met and known Governor Hoard, and believe in him most thoroughly. I have known him for a good many years, and a few weeks ago it was my privilege to visit his home town, and see a little of him in his home work, and among his people, and I assure you if you could have seen him as I saw him there, you would hold him in still higher esteem. You know how he has come to us and talked about the dairy cows, and our work about the dairy. I was particularly interested in visiting his own home creamery, the one that he manages himself, to see that he carries out in all his work the theories and the practices which he talked to us about, even in more thorough detail than anything we could imagine. He has had a very successful creamery for a number of years, where he has been supplying two or three thousand families in Chicago. He now has 4,000 on the list, and that they shall have butter, the best possible, he has just built a new creamery.

I wish we could all take a trip there to-night. It is about as beautiful as a banquet hall. The floor is perfectly cemented over, as nice as any hard cement can make it. The sides up four or five feet are beautifully tiled, and decorated with glass tile. The balance of the wall and ceiling is stamped metal

ceiling. Electric lights are used in the whole. The milk and creamery vats are made of porcelain. Absolute cleanliness must be maintained. The separators are made for them. The electric dynamos drive it all; and it is like making butter in the slickest parlor or banquet hall in Connecticut. Outside his little office is very attractive; a plot of two acres is laid out like a beautiful park, with about 2,000 shrubs and ornamental trees ready to be planted in the spring. It is decidedly a refined place all the way through; and at his home, I found just the same ideal situations. He has told us in little German stories of the strange old Dutchman, who takes care of his cows and horses, and the little hospital for the sick cow; and one of his dear old Jerseys got hurt, with a broken hip, and our friend Hoard said she would have to be put out of misery, and she was killed, and the old Dutchman came and said: "Well, Governor, must I take her skin off and save that?" and the Governor spoke about the cow, and said she should be buried in her lady-like robes, etc., but the Dutchman shook his head and said: "To lose that skin." He is a man that will do credit to American agriculture if he can be in that position. I think we will do well as farmers of Connecticut to endorse such a man, and hope and pray, whether we are Democrats or Republicans, or free silver men, the incoming administration will give us a man at least half as good as Governor Hoard.

(The resolution was then unanimously adopted.)

(Music.)

At 9:15 adjourned to 10 A. M., to-morrow.

MORNING SESSION.

(Music.)

December 17, 1896.

Mr. Brown. Ladies and gentlemen, I have the pleasure this morning of introducing to you Mr. Thompson, of the State Board of Agriculture from Tolland County, and president of the celebrated Ellington Creamery, who will kindly preside at our morning session.

Mr. Thompson. We will listen to questions from the Question Box.

Mr. Gold. "What is the best inexpensive device for removing the chill from water for our stock in cold weather?"

Mr. Fisk. I believe the best way is to let nature warm it. Our experience shows that fancy improved modern appliances for watering stock are not beneficial, if you expect to keep your herd's health, and we believe it is absolutely necessary that the water should remain cool and pure and unadulterated, for the health of the animal.

Mr. Gold. The result of experiments with regard to warming water for cattle show a very varied result; that something else besides the warming of the water, or allowing the stock to drink it excessively cold, interfered with their harmony of results; while some men, with great care attending it, have reported great improvement from warming the water, others have found if they warmed the water alone, that was not a panacea to stand in the place of good feed, care, and management in other directions.

Mr. Gold. "When rye straw will bring at wholesale in the city $20 per ton, is it not a profitable crop to grow?" I understand they require you to thresh it before they will pay $20 a ton, and carefully, too. It would seem as though it ought to be. The straw itself draws but little from the fertility of the farm, and amounts to but very little to be returned to it as a fertilizer. But at $20 a ton, there are plenty

of lands in Connecticut that should produce full crops of straw and meet this market demand for the article. If gentlemen who have stables, that want to keep their horses in good condition and clean in the cities, are willing to pay $20 a ton, the farmers should meet that demand.

Mr. Patterson. I might ask the question if it would not be more profitable to cut it early before the grain forms and sell it without threshing, wouldn't it weigh heavier than if thoroughly ripened? It is almost impossible to fill the orders in the country. In the West, it is very difficult to get the orders filled there for tangled wheat and oat straw. I placed an order which was to have been filled at $10 a ton. To-day it is worth $14 a ton delivered at Boston points. Of course the order was not filled.

Mr. Hoyt. That straw will weigh more to allow the grain to get ripe. If you cut it green it has got to lie a long time to cure, and it won't weigh any more than when about ripe. And that grain will pay for the threshing, and more, too.

Mr. Gold. "Do you advise banking in setting plums or other fruit trees in the fall?"

Mr. Edwin Hoyt. Certainly; so the water will pass off, and also to hold the trees steady. My advice always is to stake a tree, to hold it firm; but banking is the next best thing, and especially where the ground is moist, bank it up in the fall.

Mr. Platt (Cheshire). I would bank the trees in the fall. They might go through all right, but the banking helps carry the water away, and helps to keep the tree from moving in the earth, so as not to have a hole around the side of it.

Mr. Gold. There is another advantage in banking that has not been mentioned — to keep the mice away from young trees. A little banking with clean earth around the trunk, making a little mound six inches high, is one of the best preventatives against attacks of mice during the winter season. The mound should be removed in the spring.

Mr. Hoyt. Suppose you bank over that with straw fertilizer or manure?

Mr. Gold. That encourages the mice.

Mr. Hoyt. The banking of the tree would not save it from mice in case the straw is put over?

Mr. Gold. No, sir. A clean bank of earth, free from turf. Sometimes young trees, the first two or three years of their lives, are ruined by field mice.

Mr. Gold. "Has any scientific attempt been made to reclaim the sand plain below Wallingford?" I have advised our Experiment Stations to take some of that land in charge and see what can be done with it, but they have not accepted the advice just yet. It seems a practical problem for the farmers to solve themselves. A Mr. Hall in Wallingford, several years ago, who was a manufacturer of commercial fertilizers, applied them to a field of several acres, and planted it with corn, and kept an account of every expense connected with it. The corn was planted by machinery, cultivated by machinery, and showed a good return on the investment.

Mr. Brown. I submitted that question in the hope of getting some information from some of the scientific men connected with our Experiment Stations in regard to it. Now, the general government is contemplating the expenditure of vast sums for the irrigation of the barren plains of Arizona and the West, and the crop raised, if raised, has not a quarter of the market value that a crop raised between two great cities of Connecticut ought to have. It seems to me that is a practical question that ought to be considered by this board, and ought to be considered by the scientific men who are in the pay and employ of the general government and State of Connecticut. Then again, we were told by his honor the Mayor of this city that a sewage plant was nearly completed for the utilization of the sewage of this city of Danbury. Now that plain referred to, which at present is worthless, lies right near three great cities — Hartford, Meriden, and New Haven — and the sewage of those cities, if the plan adopted by the city of Danbury is feasible, would make

a garden of that desert. I consider a question of that kind is a question of practical importance, and one that should be considered by our scientific men.

Mr. Hoyt. I recollect that at one of our meetings a number of years ago, hearing J. J. Webb make this statement: "If I should sell my farm I would locate on the North Haven Plains."

Mr. Platt (Cheshire). Right in the line of what is said by Mr. Brown, the city of Meriden has already taken the extreme northern portion of this Wallingford plain, which is not so barren as the rest — between Yalesville and the city of Meriden — and empties its sewage on that spot. They have there fourteen enclosures, into which the sewage empties in about six streams into each enclosure, the enclosures perhaps 200 by 300 feet. They removed the upper stratum from this ground, which was sandy loam, and placed it in embankments, to make the inclosures. These are perhaps six feet high. The soil left inside is practically level, of a fine gravel. The sewage soaks into the gravel, perhaps not going over forty feet from the point where it empties out of the earthen pipes before it goes into the gravel underneath. It does not cover the whole surface of the bottom of the inclosure. They make no attempt whatever at raising crops there, and they change the use from one reservoir to another. Perhaps one-quarter or one-third are in use at one time. I went around there last fall and found the odor from the sewage in many of the inclosures was pretty strong.

Mr. Gold. Our friend, B. G. Northrup, who has been so much interested in forestry, advised that we might restore the forest growth to those plains, and the railroad company was interested; but there seems to be trouble between a road operated by steam and the possibility of starting a forest growth right alongside of the track; but when the good time comes that electricity takes the place of steam in running our roads, that difficulty will vanish; and if we do nothing else with

those plains agriculturally, than to clothe them again with the original forest they once carried, we shall have made a long step forward towards beautifying and rendering profitable these waste lands.

The Question Box is closed to give way to the regular exercises of the morning.

Mr. Thompson. The next on the program is the lecture on "All around the Fruit Farm," by one who needs no introduction here, Mr. J. H. Hale.

ALL AROUND THE FRUIT FARM.

By J. H. Hale, South Glastonbury.

Mr. President, and fellow farmers: In any ramble around a fruit or other farm we always discover, if we go with our eyes open, more things that need attention, thinking about, and talking about, than we are likely to properly attend to; and this subject assigned to me to talk of, "All around the Fruit Farm," has led up to far more thoughts than it would be possible to present in any one discussion. And I propose, in what little I may say, to ramble around just about as I do on my own farm, starting off in one direction, to land somewhere else, hardly knowing where I am going when I start, and may not get there in the end, but go where seems to please me best.

In thinking of the fruit farm a few years ago, perhaps we would have kept pretty close at home; but at the present time, with the broadening out, and at the same time narrowing in, of this great world of ours, we have to consider the whole world as a fruit farm. That was particularly impressed upon me a few days ago by going into my office and finding a very elaborate, tasty, and complete catalogue of nursery stock from a firm in South Africa. A few years ago I thought it a wilderness. Now to get a beautiful catalogue from the wilds of Africa was interesting. I was interested to read through this catalogue, to find the wonderful new pear called the Keifer, which could be had for nine shillings, and another you could buy for eight shillings, and other things in that proportion. The prices were up down there, but they were getting hold of some of the good and bad things of our fruit farms here.

A little while ago, in the summer, while working in the

orchard one day, a gentleman came and presented himself. He was a peach-grower from South America, taking his winter vacation up here in July, to see what he could learn of peach production. That was interesting for me, and while I do not think at present he will compete with us Connecticut farmers in the Hartford, New Haven, and Boston markets, yet I thought he was another competitor who had sprung up, and the time would come when we would have to meet him somewhere.

A little later a man dropped in to my farm who had come from New Zealand, who gave me an insight of what was going on there in fruit lines, where it was a wilderness a few years ago.

So all around the world there is tremendous broadening out of the fruit farms. Our own great North American continent is a wonderful fruit farm, and one that we have got to go all around it to know how big it is, and what its possibilities are, and what we have to meet in the future. Of course, we think particularly of our own United States, and we boast of the wonderful apples we grow here in New England; but the friends over in Canada and Nova Scotia are planting apple orchards, to supply Boston and other New England markets, and growing them in a way we in New England have not thought of at the present time, but we will have to when we meet them in the market.

In the United States the development of the fruit farms is going on all over the country. I don't know but I spoke of it in our meeting last year, the land advertisements pushed through the West in the papers, of the wonderful apple regions of southwestern Missouri and Arkansas. Most of the advertisements read: "Come to the land of the big red apple." If you go there and study into their situations you will find rocky hillsides covered with scrub oak and other trees, that are no better or easier to get rid of than many on the Connecticut hillsides; but the big apple is there. But the land of the good big apple is at home. We can grow better apples, and as many of them, as anywhere in the country, if we will.

To talk about apples in the fall of 1896, when we have been over-burdened with them, and have felt that the profit of raising apples was a delusion and a snare, to speak of planting any more apples at this time I will admit is a little dubious. Yet I believe the blessing of the apple crop of 1896 is one of our

great blessings — one of the things that we as farmers and fruit producers should give thanks for. The great abundance of apples in America this year has opened up markets we have never heard of before. Just a week ago or so I was making a trip through the Southern states. In previous years there has been no time within my memory — and I have known the South pretty thoroughly since the war, been there frequently — that apples in barrel lots were on sale in any but the larger cities. Atlanta, New Orleans, and so on, were about the only ones that received apples at all. With the abundant harvests here, and the looking about by sharp men to see what could be done with them, they have gone into the little towns with apples in car-load lots, and in nearly every place where apples have been a burden at $1.00 or $1.25 — scarcely a barrel at $1.50 — they have gone into the little towns in car-load lots, and where they have occasionally in former years sold a barrel or two to a grocer, they have now sold large orders. That thing is true of all sections of the United States where apples are not grown. They have got them this year. They have learned how good northern New England apples are, and are going to have them in the future. Any commercial fruit-grower here, who has been long in the business, will tell you that a glutted market is a blessing. A scarce market gives people the impression that fruit is scarce and high, and they do not look for it; but flood the market once and they will look for it, and they will consume more and more. So there are some blessings in the last year's fruit crop.

We in Connecticut are rapidly developing into a great fruit and vegetable and dairy farm; and the growth of fruit culture, the development in our own State, in the last ten years is something marvelous. A few years ago each one of us who was near a good town market practically had that market to ourselves. Now it is entirely another thing. One of the gentlemen was asking me here yesterday on the subject of planting peaches. "What varieties are you planting now?" When we commenced ten years ago, when there were not perhaps 50,0000 trees for the commercial markets, we said: "Let's plant trees that will come in the market when Delaware and New Jersey peaches are out of the way." We want to plant late varieties, and we will have the market to ourselves." So we planted late varieties. In the course of the last ten years we have learned two things; one of them is,

that we need not be afraid of New Jersey or Delaware so far as the quantity and quality are concerned. We can beat them out of their boots in size and flavor. We need not fear the competition of those people. But we have to look out for our neighbors. The sharpest competition in Connecticut at the present time is with the other fellow over the other side of the fence. Our own neighbors are the sharpest competitors now.

The question now is, how to plant the varieties that best suit our soil and market, and be on the alert to beat the other fellow, if we can, and bless him if he gets ahead of us. We have to do that in all our work of commercial fruit growing; and while this talk may touch upon the situation of the amateur, and should, we, as I say, are a commercial fruit-growing State, and we have been spending altogether too much time in the study of varieties in the matter of production. We have spent all our time in thinking about the production of fine fruit, and very little about the marketing. We have left the big business end to take care of itself. That is where we made a mistake. The time has come now that we should spend the most of it in the business side of it — that of the marketing. There is some reason in that. In our closely populated districts many of us have been able to sell our production in the near-by market, and have not had to consider the transportation problem, except as it concerned the old horse and wagon, and getting up early in the morning. We have not had to consider the question of commission men and their handling. But we are fast coming to studying the business side of it. It is one thing to grow very fine fruit, and entirely another to sell it. And while we never shall, perhaps, be extensive shippers of fruits outside of New England, we shall probably for many years ship to adjoining states in New England, and therefore have to come in contact with railroad men and railway service, and we want to go at that in a business way.

Now, brother farmers, we hear a good deal of talk against railroads and railroad management. Men are attempting to run railroads in this country who cannot run their own farms; and they don't make a success of either. I have found, in contact with railroad men, that they are a good deal like other business men:— that their business cannot be a success unless carried on in a business way; that their business, and the business of their customers, is identical; that there must be a

mutual interest there; and if they are approached in proper ways there is no difficulty in getting the railroads to give you as good service as possible within reason, and at what ought to be a satisfactory rate. I do not believe, with the intelligence of the Connecticut farmers and fruit-growers, as we come to ship more and more fruit, that we shall have any trouble with the railroads in getting the service we need, and at satisfactory price, if we go at it right end first — and that is, to meet the managers of those roads — not the under-strappers, but the men at the top, talk to them in a business way, and get our fruit into the market as quick as possible, and in the best possible order.

Then comes the commission man. He is not to be despised. He is an important factor in our work. I consider the commission man in the city, or the railroad president, as much in my employ, so far as the business is concerned, as the man who holds the plow or gathers the fruit. We are all workers together.

I met a lady on the train the other day, and she was speaking of the fact of Uncle William producing a nice lot of fruit last year; but the commission men robbed him, and sent him back only so much. I happen to know Uncle William — dear old blunderbuss — does not know how to handle fruit properly; and it was probably picked a day or two after fully ripe; it was put in unfit packages, and I have no doubt got to the market in very bad condition, and that the commission man worked as hard as he could to get a satisfactory price for it, and returned to Uncle William all he got, less expenses; and yet Uncle William honestly believes he was robbed.

I have been studying and working with commission men in our New England cities and other cities, and they are, in the majority, upright, honorable men. They work harder than the average fruit-grower ever has worked, and make longer hours. There are plenty of them. The trouble is we do not go to the city enough to study their methods and the wants of their customers.

After you have settled down on a man who understands his business, get him to come on the farm and get in sympathy with your place and see what you are doing; show him that you are producing as good or better fruit than he usually gets; show him that you aim to handle it in every detail in the best possible manner; show him you pack it in clean packages, fully

and honestly packed. Then let him go home, and ship to him, and ship him your fruit in the utmost confidence that he believes in you and your fruits, and he will sell them at the biggest price possible. I tell you, to make the business a success we must have confidence all along the line, with the commission man, with the retail dealer; and then we will reach the consumer, and get his pocketbook open, and keep it wide open, and pick it with choice fruits, if we do our business in this way, but in no other.

I have been a little interested this year to notice in some sections of the country, notably in western New York, although it has been a little common in New Jersey and Pennsylvania, the street fairs of farmers and fruit-growers getting in touch with the retail dealers, and getting the privilege of making an exhibit of farm products, of vegetables as well as fruit, at a certain store, showing him you are trying to produce a little better article than ordinarily comes to the market, and you would like the privilege of exhibiting it — keeping on exhibit from week to week samples of your products. What is known as "street fairs" have grown up, where farmers have been making these exhibits, mostly with stores that deal in those lines of goods. It makes an attractive display for the dealer, and it has brought the products directly to the attention of the consumer so he has known the product of A, B, and C.

Our manufacturers when they manufacture a fine product advertise it; they stamp their name on their wares; they stamp an advertisement on each wrapper, and perhaps on the whole package; they are all labeled with the name of the manufacturer. So a man who has a good article, and is satisfied with it, knows where to get it.

A question came up the other day in a horticultural meeting, "Which is the best pruning shears?" A man told the name of some, because the name was stamped on the shears; he had used them and knew a good thing, and the man who made them stamped it on the shears. We must let the men and women who buy know who produced it. And these street fairs are a splendid way of putting before the consumers the wares they like, and proclaiming who produced them. There is where the money is. Do away with as much of the middlemen as you can, and get close to the consumers.

In our own farms in Connecticut, if it is a general fruit farm,

just what we shall plant, how we shall plant, and where we shall plant it, is a local question. It depends as much on the man as anything — somewhat on the soil and markets. If not a general fruit farm, but simply a general all-round farm, there should still be fruit there. I know many of our farmers object, that they do not grow what fruit the family requires because it takes up the best land, or they do not want to shade this field or that. I found in my travels around Uncle Sam's farms in the last year several general-purpose farms, where the fruits were grown around the borders of the farm. All around the border were apples, pears, peaches, plums, cherries, and quinces, each in that section of the farm best suited to its production, or most convenient for the family to get the fruits as they required, the winter apples and pears being at the further end of the farm, and the cherries about the nearest point to the house.

While we know all these things respond most readily to thorough culture, and need it for their best development, yet I found one rocky old farm where these trees were mulched with stones around them. I found some apple trees, and plums, and peaches growing luxuriantly, mulched for 10 or 15 feet around with nothing but stones. They had been fed occasionally with chemical manure, spread on top of the stones, and which the rains had washed in. It was a peculiar method of culture, to my mind, but the results were satisfactory.

In establishing a fruit farm in a near township to this, a large plantation cleared this summer, I am under the impression that I shall take up mulching with stones. I do not know what the result will be, but I think it will be right in a few years.

There is no question but what if our fruits and plants can be put in the open field we can get better results.

I noticed in the last account of the Massachusetts Fruit Association, that in their travels around old Concord, they went to Mr. Bull's farm. They traveled around there, and went to see the old original Concord vine. But it was overrun with grass and weeds; a few scraggly grape vines with four or five grapes to the bunch. Think of it, in regard to this alone, where the bunches are made to weigh a pound apiece, brought about simply by cultivation of the same vine, but cultivating and feeding it along particular and intelligent lines.

When a man fails in producing any particular standard

fruits to the highest perfection, the trouble is usually with the man, and not with the tree, or vine, or location—because there is hardly an acre of soil that is tillable in the State of Connecticut that somewhere on that acre some particular choice fruits can not be grown to the highest perfection — even on those plains of Wallingford.

Of course, in studying the soil we should study the types of trees and plants best suited to it. Certain ones will thrive best on clayey soil, and others on other soil. With pears, the Beurre Bosc, one of our choicest pears, needs a stiff, heavy, somewhat wet clay, such as they have on the west side of the river, where it will grow to high perfection, and fail entirely on a sandy, loamy soil. So it needs a little study as to type of trees, as to particular styles. So with plants. This wonderful Marlboro Raspberry, which grew so beautifully as plant and berry on the heavy soil about the home of our fruit-grower at Marlboro, N. Y., has failed almost all over New England; and yet there is a little section of Massachusetts where they have the same kind of soil, where it is doing admirably. Some plants, like people, will land on their feet wherever you put them. Those are things we have to look at.

Then comes the question of new, or old, varieties. In planting for the family supply, when you want to know that every tree and plant is sure to give you something of satisfaction, plant only of those varieties that have been tested in your immediate neighborhood and are known to do well. If you want to experiment a little, test the new varieties. But be sure to have for all-the-year-round supply only those tested well-known standard series, which, if not all equal to promises of some of the new ones, are certainly a great deal better than none, and good enough in their variety to give us a supply through the year. But the commercial fruit-grower — just the same with him in planting on a large scale, he can ill afford to take up the choicest land and best preparations, and years of cultivation with unknown and untried varieties. He must also be on the alert all the time for the newer and more improved varieties, or his rival will get ahead of him.

Those of us who are growing small fruits to-day probably have not 50 acres of strawberries, of the varieties we cultivated fifteen years ago. Probably 75 per cent. of all now growing, of the profitable ones, are of the varieties known eight years ago. Probably what we will grow ten years from now will be

varieties unknown to-day. Not so with raspberries, blackberries, and currants, but so in a considerable degree. While you want to hold to that which is good, hold fast to the old and true friends, you must be alert for the new ones, because there is progress going along very rapidly in the production of fruits at the present time. You cannot learn this all from the fields. You may visit your brother growers from this and other States, but you must visit the markets also.

A few years ago we were all gratified and astonished almost with the magnificent show of the Niagara grape, that child of the Concord, which, with its parent's vigor, attracted so much attention. Probably next to the Concord it is now being grown more largely in amateur grounds than any other — showing that people grow it if they like it. As a matter of fact, study the markets and you will find that you can sell 100 baskets of Concord, or some purple grape, to every package you can sell of the Niagara. I cannot explain why that is. So the commercial man must study that from both sides, and find he better not grow many white grapes, or light fruits of any kind. People seem to like color in the market. You must catch their eye with color, and get the pocketbook open with it.

We talked a good deal in times past about the hardiness of varieties, and it used to be a notion that our raspberries, blackberries, and plants of that class, and our trees had to ripen up well in the fall; and we would see our raspberries and blackberries shedding their foliage in the early fall, and think they were right to go through the winter. We are beginning to learn that to have the plant ripen up well we want it to hold its foliage long. We talk about tender blackberries, that the plants we grow earliest in the season should come to maturity, but the late suckers that come up, if there is anything left alive, it is those last plants to develop, those that hold the foliage last are the ones that go through the most trying times.

We have talked with some — I don't want to say nonsense, exactly — about peach culture. There is hardly a thing today we want to guarantee that we believe to-day we will believe to-morrow. We do not want to be very positive, or too positive, at least. We have talked about cultivating our peach trees up to about the middle of July, and quitting so they would go through the winter all right. This early development of peach buds, this ripening up as the wood ripens, they develop

earlier and come to full maturity and are solid there on the trees early in September, fully rounded out by the middle of September, or earlier, and the foliage sheds in October, and we get the warm weather — as we have had lately — and our buds are swelling for spring almost before they ought to have stopped growing. I think perhaps, we shall be able to carry fruit buds — peach buds particularly — through the winter if we will keep up the culture later. I believe there is a little work for the Experiment Station to do. I believe Prof. Phelps has a peach orchard at Storrs. I wish a portion of that might be kept growing much later in the fall than usual, and see if we cannot stop that growing of the buds, so they will not be swollen in the fall. I believe in future years the whole of my orchard shall be cultivated and kept growing much longer. We know that in our young trees the longer we keep them growing, while there may be a little tendency of killing the tips that have not come to maturity, upon the whole, there is less loss of wood or fruit bud from the late growing of the trees. I consider that subject worthy of considerable attention.

The question came up from the Question Box as to earth mounding around the trees, and certainly what Mr. Platt, Mr. Hoyt, and Mr. Gold said all together covers the ground thoroughly. All young trees and plants should be mounded up in the fall, for their protection against swaying about by the winds. Young trees sway a little, and leave a little hole about them, when the water will run down (with a large tree it might do no harm), until the frost gets in and perhaps works serious damage. Then there is not much danger from mice, only in deep snows. The roses and other things we cover with a straw matting of various kinds. The winter protection of raspberry and blackberry, by the acre, is a simple process; mounding up at the base of the plant, and bringing the plant over gently, stretching it down, and covering the top, and driving the plow down the row; and those who do it find they can be covered and uncovered at an expense varying from $6 to $10 an acre — which is cheap insurance for the wintering of them. Use earth mulch wherever you can, even in the strawberry bed; it takes considerable earth, but if you have the time there is nothing better than a dusting of good loam, the best mulch I know of.

On the question of mulching strawberries, we have talked

in the past that our mulch was entirely for the purpose of spring protection — protecting the plants against freezing and thawing in the spring, which tore the roots; and that is the great purpose of winter mulching, to guard against that — to keep the plants frozen up, rather than to keep them from freezing. It is also a great advantage to prevent the freezing and thawing in early fall; and I would say, always have a light mulch on the family bed, as soon as the first freezing weather comes in the autumn — not enough to shade the plants entirely from the air and sunshine, but to shade them considerably, and you will find they will keep on making strong root growth much later in the fall. I tried it last year, and the bed that had the early fall mulch gave me more than double the berries, because many of the other plants set no fruit at all. I believe it will pay us well to mulch our strawberry beds earlier than we have been doing.

The question of the peach borer is coming to be an important one as we have more trees in the State. We used to talk about the borer, the moth or insect flying early in the season, and we would put a wash on our trees in the latter part of April and May to keep them away; but the present light on the subject seems to show clearly that this insect does not hatch out and become an egg-laying pest until midsummer — and then is the time to work against it — the eggs being laid in midsummer, and hatching out; and while we dig out from the trees in the fall a small worm, they are hard to find among the gum and sawdust at that season; but they become of full growth the following summer, and do the worst work in the tree in May or June — and then we should dig them out as thoroughly as we can. Some have thought that earthing-up about the trees in midsummer, at the time these worms are changing their state, has helped smother them out entirely. I don't know whether that is so. But there are peach-growers in Michigan, and in this State and elsewhere, that have found less trouble with the borers where they banked their trees in the early part of June and left them banked until mid-September. They found less of the borers in their orchards where this was practised. I don't know surely whether there is any good reason for that practice, but there have been some practical results indicating it may be desirable. There are experiments going on at the Cornell University Experiment

Station, where they have an experimental orchard of fruit trees, and they are working after this borer.

The curculio I have had a tussle with the last year. He is always with us, and sometime I expect he will wake up in all his majesty and give us a fight in Connecticut. In Georgia the last year we found that insect very prevalent. Our peach growers in Connecticut are finding that the curculio is one of the serious pests. While they never have stung our fruit in the whole orchard, on the outside rows they appear. How soon it will tackle all the rows of the orchard no one can answer; but we ought to be prepared. A little experience in my Georgia orchard last summer gave me some work to do, and some result, which convinces me that the curculio may be controlled. We know up to the present time that there is no way of preventing his work except by catching. Catching a small measly bug is quite a serious problem. The old way of jarring, and catching them is the only known remedy. We determined that should they appear again this year we would fight them. So, early in April—which would be June here—when the peaches were as large as walnuts, we made some experimental jarrings, and found that they were there in considerable numbers. We then made a trapping outfit, which I have a picture of here. We took long narrow strips of lathing, 16 feet in length, and bowed them to a crescent-like form, and put another strip of lathing across the two ends, forming a crescent, on which we tacked sheeting. It was large enough to go under one side of a four or five-year-old peach tree. Three cords formed a handle. You could grasp it in the hand and bring it under the tree. After some experimental workings, we got some oaken clubs 3½ feet in length and covered them with broken bicycle tires; and two of these outfits brought together under one tree made a great inverted umbrella to the tree. Knowing that with the ordinary means of jarring it was a serious problem to tackle a single tree and save the fruit, when you come to tackle 100,000 trees in the same way many thought it could not be done, and nearly all my friends said they knew it could not be done. We started in, and found the curculios were plenty, beginning the latter part of April, with fifty men and boys, two under each tree. When they were all together under the trees, each man with his trap brought together, one man, who was commander, said "Go," and the tree was banged quickly, and then go to the next

tree and bang again, and so on clear across that 500 feet of row to the other side, and there they were met with negro boys with buckets and kerosene, and made a dump. The men were given a chance to rest. You must move quickly or the curculio will hop off and away, and then rest, and back across the row and bang again. After a few days we got so expert that they would get over 50,000 trees a day, or 1,000 trees to a man; and the whole orchard was gone over every two days, and that was kept up for seven long weeks. Now

CURCULIO CATCHERS AT WORK IN PEACH ORCHARD.

I expect that is the biggest fight of the kind ever had in this country, if not in the world. When you think of keeping fifty people at work for seven weeks jarring off bugs, it is quite a proposition. My neighbors laughed at me. My Ohio friends, who had adjoining orchards, said it would all do very well, but it wouldn't pay. The result was that we had the only sound crop of peaches produced in the State of Georgia. We had one-fifth of all the sound fruit that went out of the State. We had some sixty car-loads of not all sound fruit. We sent about 80 per cent. of the fruit perfectly sound. It was a profitable thing to do. So that while you may think that the curculio attacks your plum orchard, if he gets into your peach orchard you must let him work, I assure you that if the curculia tackles the peach orchards of Connecticut, as he will

sooner or later, you must be prepared to jar them and get them off. Later in the season, when the curculios were less prevalent, each warrior carried a little tin box, and they gathered up the curculios, and we gave a premium for the fellow who got the most each day, so as to make them thorough in the work. We kept the fight up until a man could not get over 25 a day.

The process of jarring, while it looks like a serious one, can be done successfully, and at a cost which the fruit will pay for. While labor is much cheaper in the South than here, every dollar invested in that fight returned us a little more than eight in increased quantity of fruit, the price based on the nearest neighbor's orchard.

We are doing a good deal of talk about irrigation in the State of Connecticut, and in the future we are going to irrigate our farms more and more; and we want to understand, that while it is one thing to have water, and an abundance of it, it is another thing to use it at the right time, and few people irrigate early enough. We are talking about irrigating strawberry fields. We thought it would do after the blossoms formed and fruit well set, that that would be time enough to turn on the water; but experience has shown that you cannot turn it on any too soon after the frost is out in the spring. If we are going to get the greatest results from irrigating, we must begin to irrigate early. Also in our fruit orchards. I turned some water into my apple orchard early in the season, and kept it there whenever I could conveniently spare the water. And those Baldwin apples had the same food treatment all the way through. Those that were irrigated were more than double in size of those that were not. I know another party who began in August and did not get such results as when it was turned on in June.

As to the question of handling our fruits after they are matured. There has been talk in former years about cooling our fruit and giving it abundance of air. We have heard that thing too much. Pick your fruit any time of the day you can. Cool it as quick as possible if you want it to keep, but get it out of the air. Your packing shed and storage-room should be free from currents of air. The air wilts it, and causes it to lose its showy appearance quicker than anything I know of. It applies more to small fruits than to anything else. In my peaches sorted in the morning in the fresh air, the style and

beauty goes from them quicker than those covered up and kept out of the air and light.

The one neglected fruit in Connecticut at the present time is the cherry. We have not been planting cherries to keep pace with the other fruits. We want a considerable extension of cherry planting before we shall have among ourselves all the good cherries we want to eat; and then the markets want a great many more.

We have been talking a good deal about chestnuts in Connecticut the last few years. I want one of our Experiment Stations to go and buy a good piece of chestnut sprout land, about ten acres — plenty down near New Haven some one will give you, or you can buy it for a few dollars per acre — but we want an experimental chestnut orchard in the State of Connecticut, whereby they shall give us a better knowledge of the grafting of these nuts. It is a pretty difficult problem to graft chestnuts. We are doing it in the nurseries of the country, and all over the sprout lands, but we have not got on to just the right how of it, to make sure of it. I believe the time is coming when we are going to have hundreds of acres of commercial chestnuts in Connecticut, and land now offered for $3 to $5 an acre is going to be worth as much as the best land, for chestnuts. My own experience covers only about three years, and I have failed about nine times out of ten; but the surest and best success I have had is when the scions have been kept packed on ice, and when the stock in the open field have been half-leaf or more, and then I have succeeded in having a greater per cent. grow. I have also succeeded in making the descendants of Japan varieties take more than those with European blood in them. I would like to ask Mr. Platt if he has noticed that there is little if any difference between the Paragon and Numbo and Ridgeley. There is no difference in the habits of taking to the American stock.

Mr. Platt. I never had the Ridgeley. Of the other two, I don't know as there is any difference in their habits.

Mr. Hale. I want chestnut experimental nut orchards somewhere, and want to serve notice on the Experiment Station that that is one of the things they should do for us.

There is another thing there has been a good deal of feeling about — talk about getting the fine roots, and then we could

make all trees grow. My observations are, that it is hardly possible to handle a tree or plant in our own grounds, and keep it out to the air the little time we must, without the majority of those fine roots dying away. If we get a few tap and leading roots, that is what we must depend on, and then add clean, close pruning of the roots. Do not try to save all the roots, but get beyond the bruise; get a clean, smooth cut. I think much failure of fruit planting comes from planting the tree just as it comes from the nursery; the wounded end of the root is sore, and decay sets in; while with a clean smooth cut at the end of every root or plant, setting out that as soon as made, it throws out all new roots, that give us those fibrous roots we want. The attempt to save every root is useless.

The question of when to plant is, of course, an important one. Most of our deciduous fruits, except the peach and small fuits, the strawberry and Black Cap Raspberry — can be planted early in the fall, as soon as the foliage drops, if planted in sandy soil — but on moist or clay soil do not touch fall planting; but when it comes to spring planting, do it just as soon as the ground can be worked. Every day's delay after the frost is out of the ground, and it has become in working condition, is dangerous delay. Do not hesitate, if you have to buy trees and hardy plants, to buy them in the fall. You say, "We do not want them in the fall; we do not know how to handle them." The majority of nurserymen take them up in the fall. They are stacked up and kept packed in cellars, and it would be far better for the average planter, who is planting anything but peach trees, or strawberry, or Black Cap Raspberry, to place the order in the fall, to order the nurserymen to dig them after the foliage is dropped, and ship them, and put them in the ground well covered root and top, and they are then ready to plant the day you want. Plant in the spring.

Thinking about our opportunities in Connecticut, I think I spoke a year ago about the wonderful opportunities of our markets, and the increased refinement of our people. I met the other day Prof. Tracy, who has charge of the field work of the D. M. Seed Co. He said: "Hale, I wonder if you people in Connecticut realize what a garden spot you have? Why, the best horticultural fields in America are right in your State of Connecticut. I wonder if your own people are awake to the possibilities of soil culture in the development of fine

fruits and flowers, and the glorious opportunities you have for marketing?" I have felt that way myself, and was glad to have a man who lives and travels over the prairies of the West talk that way. It is so. While we are growing fruits for the market, and our opportunities are great and going to be constantly growing broader and better — possibly we may meet with lower prices.

I was interested in the talk Prof. Atwater gave the other day in relation to prices going lower. I think that is true; the tendency is towards lower prices; but I wondered whether salaries would be cut down proportionately; certainly they will have to be, because they do not need so much. They can buy so much more with the little they have; I hoped he would bring that in, but he did not.

While we are thinking of these things from a commercial standpoint, do not let us forget the home. Do not think any ideal home, worth calling a home — a home that all the better instincts of life can be developed in, can be brought about without an abundance of choice fruits and flowers, with the ornamental trees and grasses that grow with them. I hope we will give more attention to the production of choice fruits and flowers. Do not let us spend too much of our income in the development and maintaining of the Foreign Missionary Society, when there is such great work for home missionary societies around the farm home, in the better understanding of the possibilities of our own soil and the opportunities that may come from that soil. I do think that we have not thoroughly opened our eyes to the possibilities of our own homes as beautiful places to live in, by properly grading a little here and a little there, the maintenance of a fine lawn, and of beautiful shrubs and trees and plants thereon; and then near by, where the mother and sister and little children can have at all times just for the gathering, the beautiful, luscious fruits that come out of the ground. The good book tells us that "The Kingdom of Heaven is within you;" and it is within every home farm and every heart, if they will only fit the conditions to enter that kingdom of heaven. I hope we shall do it. (Applause.)

The Chairman. Are there any questions you would like to ask brother Hale? Such will be in order now.

Mr. Gold. I want to ask Mr. Hale about the result of Mr. Coe's experimental chestnut orchard this last season.

Mr. Hale. Mr. Coe's orchard, at Meriden — he has taken more interest in chestnut culture perhaps than any man in the State, and he had 18 acres of chestnut sprout land grafted one, two, and three years ago; but during his absence in South America last year, a forest fire got into an adjoining wood, and spread to the sprout land and killed many. The balance of his wood he had sent to Georgia, and he had little of new wood for grafting. I think nothing has been done during the past season, especially as Mr. Coe is in very poor health.

In this chestnut line, perhaps some of you have noticed the exhibition of the little plate of chestnuts. Mr. Burbank of California originated one, which Mr. Coe bought. Later he originated another one from seed that came into fruiting 18 months from the time the chestnut was planted in the ground, and Mr. Coe bought this also. Some of this wood was sent to Georgia, and it was cut in single eye-grafts, and crown-grafted at the surface of the ground on one year seedlings. There are nuts on that table produced in the season of 1896, from wood which was one single bud set last March. My explanation is this: They made a good strong growth early in the season; probably in June or July stopped growing, rested up and then started new growth, bloom was formed, and nuts formed and ripened late in the fall. On one of these trees were seven burrs, with 14 or more nuts — in one summer from a single bud; certainly a horticultural wonder.

Mr. Gold. Should we have believed him if he had put this in as the turning point of his address here to-day? We should think he had been studying this over in his mind until a large part of the statement had grown there. With all respect to Mr. Hale, I say this. But I have had no conversation with Mr. Hale on this question, and I wanted to know something more of Mr. Coe's orchard.

I want to say here, in reference to my own small experiments in the way of chestnut culture, I made a greater per

cent. of success two years ago than Mr. Hale has. Something like over 50 per cent. of my scions grew, grafted in the top of young chestnut trees. Last spring we had a very persistent drouth about the time of grafting, and my success was not quite as good as the year before. I have not counted up results yet this fall to see. But my opinion is, it is not a very uncertain operation grafting chestnuts. There is more difficulty in regard to the hickory. I want to know if anybody is succeeding in that.

Rev. Mr. Meech. I sent to the publisher of the quince book to forward it to me, and I see by looking it over that about one-half of the work is devoted to chestnuts and walnuts, which you are particularly interested about in Connecticut. Here are cuts illustrating the grafting, and description of the varieties, and also the walnut.

Mr. Gold. I would say that in regard to the hickory, I have tried that a little, and have only just got success enough to encourage me to continue it. Four small stocks were selected in the field where they were growing, and cut off just at the surface of the ground, and a rather feeble scion I had been keeping was inserted in each, and out of the four, one has made a moderate growth last season. Whether it will survive the coming winter and the accidents that may happen to it among the sprouts in the border of the forest, I cannot say. There is just enough to encourage me that I may do better at another time.

Rev. Mr. Meech. We have grafted it with great success in Vineland.

Mr. Gold. Our Experiment Station friends have been taking up some hickory stocks and planting them in their gardens, and the double shock of planting and grafting is a little too much to undertake in one season. Our first show of success I believe will be in the line I have indicated. Go and select your stocks in the field in the natural place, and while they stand there, graft them.

Prof. Britton. I would say that out of 56 grafts I got one

to take, of hickory; but I am well aware the conditions were unfavorable all through. To begin with, we found only a few sprouts on our land, and we sent away and got 150 seedlings. 100 were shellbark hickory, 25 pig nut, and the other 25 butternut. Prof. Van Deman told me he thought if I had them all grafted a little below the surface of the ground I would have little trouble. I tried different kinds of grafting; also tried it upon a few sprouts which came up on the place. The only graft which took, was one inserted below the surface of the ground in a stock of the same species — shellbark hickory; but plenty of the seedlings are left, and I shall try them again next year, expecting to get better results.

Rev. Mr. Meech. I am very sure you will all find true what the Secretary suggested — if you undertake to graft them the same year you transplant them you will fail. In this work I think Fuller recommends crown-grafting for hickory as the best method.

Prof. Phelps. There is one particular phase of Mr. Hale's talk that has interested me in the last year or two, and that is the irrigation phase of the fruit question. It seems to me here is a field for investigation and trial by the farmers that promises very good results. We have done a little experimenting along that line. We, unfortunately, have not been able to publish very much in regard to it, because the work is done primarily under the auspices of the Department of Agriculture, and they claim the right to publish first; also claim the right to use their own time in getting ready to do that publishing; but we hope to be able to publish something ourselves in the near future. I was especially interested in the point Mr. Hale brought out in regard to early irrigation. One man reports that early in the spring there came on a few days that were rather dry (he was quite an extensive strawberry grower), and he and his boys thought they ought to begin irrigating a little. They watered some four or five rows across the field, and some other work came up which required their attention for a day or two, and two days later there came

on quite a heavy rain, and there appeared to be no further need of irrigation. This farmer said he noticed the condition of those rows along through the season, which happened to be a season sufficiently wet, so the ordinary farmers would say they needed no irrigation. But he said all through the season you could notice the difference in the condition of those rows, and the amount of fruit was larger. Prof. King has just about doubled the amount of dry matter obtained in crops like corn and clover during a season, even where there was a pretty fair amount of rainfall, simply by using more water for irrigating purposes. With the strawberry, we know it is about 95 per cent. of water; and if we can increase our yield of fruit double, as we did in 1895 by the small amount of experimenting we did at Mr. Eddy's — we about doubled the fruit by a few applications of water — that is a very cheap way to increase our fruit—for certainly the water is not very expensive, except in getting it on the field. In many instances I realize this is a very important drawback, the difficulty of getting water and making it available at not too great cost. There are many farms in Connecticut where irrigation can be put into operation very successfully and profitably.

At 12:10 recess was taken until 2 P. M.

AFTERNOON SESSION, December 17, 1896.

(Music.)

Mr. Brown. Ladies and gentlemen: We are fortunate in securing, to talk to you upon one of the most important subjects connected with Connecticut agriculture, a gentleman who knows all about the subject upon which he is to speak. I have the pleasure of introducing to you Mr. A. F. Hunter, of *Farm-Poultry*, who will now address you.

POULTRY FOR PROFIT.

By Mr. A. F. Hunter.

Editor *Farm-Poultry*, South Natick, Mass.

Mr. President, ladies and gentlemen: I am afraid the promise of your vice-president is rather broad, when he says that I know all about it. I can say this, however, that "what I know and what I do not know would make a big book." Probably what I do not know would make the larger one.

It is always a great pleasure to me to meet an audience of farmers. There is an inspiration in it. There is something more than an inspiration in meeting an audience of Connecticut farmers, for I have the feeling that the subject I bring to you to-day is one you perhaps are not so familiar with as you are with fruit and some of its allied topics. I have had the pleasure this morning of listening to a most interesting address upon fruit culture, and it is with great pleasure I follow Mr. Hale in talking upon poultry. The pleasure is greater because poultry and fruit go so well together. Poultry is a great advantage in a fruit orchard in many ways, and if you Connecticut fruit-raisers would raise more poultry you might be able to keep within the State something of the about $1,500,000 you now pay out for eggs every year. It may surprise you to know that you do pay that out. I was surprised last night to learn that at Storrs College they are buying Western eggs to-day; have to, to get any. In Massachusetts we buy about $5,000,000 worth of eggs every year from outside of the State. The little State of Rhode Island buys about $500,000 worth of eggs, although we consider it a poultry State. That I shall give you in the story I have to read you, and afterwards we will have a friendly talk together upon the question. The main subject of my essay is eggs, but the real title is "Poultry for Profit."

I come before you to-day feeling a good deal discouraged, or in somewhat the same state of mind as was the Apostle Paul, when he exclaimed against the foolishness of preaching. It certainly is discouraging to learn that the consumption of eggs is increasing more rapidly than the production, and that our New England States are paying out more and more money every year for eggs bought in Canada, the maritime provinces to the east of us, or the great farming States of the West.

It is unquestionably true that egg production is increasing, that people are keeping more stock, and taking better care of it; hence, are getting a better return from their poultry. That gives us a bit of encouragement, but when we find that Massachusetts pays out upwards of five millions of dollars a year for eggs brought in from outside; that the little State of Rhode Island pays out over eight hundred and fifty thousand dollars a year for eggs brought into the State, and that Connecticut, as nearly as can be ascertained, keeps pace with her sister States, it certainly looks as though we should not immediately overdo the business of egg production. I have been inclined of late to ask myself the question, what advantage is it to tell the people of the profit there is in eggs and poultry, or to edit a paper which for several years has been preaching the profitableness of poultry raising, and what a comfortable living could be made on a farm, with eggs and poultry as the chief money crop; when I find there was brought into Massachusetts in the year 1895 over nine hundred thousand cases of eggs, for which almost five millions of dollars was paid. This amazing total is of the freight returns only, of the eggs coming into Boston by rail and boat. I personally know that quite a number came in by express and do not appear in the Board of Trade returns at all, so that we are well within the bounds of truth in saying that the consumption of eggs purchased outside the State exceeds five millions of dollars per annum for Massachusetts alone. Connecticut has several distributing centers, and draws the bulk of its supplies from New York city; hence, no accurate statistics can be obtained. Still, estimating by the average consumption of Rhode Island and Massachusetts, Connecticut must pay out a million and a half of dollars annually for eggs from outside the State.

Let us consider Rhode Island as an example of a State from which a good illustration can be drawn. We think of Rhode Island as a great poultry State, and naturally the conclusion would be that she has eggs to sell, sends a good many eggs to other markets, and it comes with a shock of surprise to us to learn that she imports, year in and year out, eight carloads of eggs a week to supply the demand. Eight carloads of four hundred cases each, means thirty-two hundred cases of eggs a week, 166,400 cases a year—almost five millions of dozens of eggs in a year.

One excellent authority estimates the average value of those eggs at eighteen cents a dozen, another at seventeen cents a dozen. Taking the figure between the two, and calling them seventeen and a half cents a dozen, we have a total of $873,600 paid out by that little State each year for eggs. Surprising, isn't it? That $873,000 would give over eight hundred dollars cash to a thousand farmers, or over four hundred dollars cash to two thousand farmers, and with fowls which would lay one hundred and fifty eggs apiece in a year, it would take four hundred thousand additional fowls to produce those eggs, which would mean four hundred fowls on a thousand farms. Why are not those eggs produced on the meagrely cultivated farms of that State, and that astonishingly large sum of money kept at home? What a difference in the condition and comfort of the families would result in four hundred dollars additional cash on each one of two thousand farms! There certainly would be very much less dread of the annual visit of the tax collector; and yet the condition of things in Rhode Island is exactly duplicated in Massachusetts and Connecticut, and in all of the large manufacturing States. Is it surprising, then, that a man in my position should be discouraged when he realizes how little heed is paid to the admonitions of experience, and the advice he has for years given to farmers to raise more and better eggs and poultry, is like seed that falls upon stony ground? That egg production is to-day one of the most profitable branches of agriculture that we have in New England, is most certainly true, and it is singular, all things considered, that more attention has not been given to egg and poultry production. In New England all of the conditions are most favorable. We have here the best markets in the world, and a constantly increasing demand for fresh eggs at good prices. As we said before, the demand increases more rapidly than the supply, ample proof of which is found in the increased importations shown in the Board of Trade returns, as well as by figures taken from my own books, which show a steadily appreciating value running through a series of years, so that the average price paid, by our grocer at the door for our eggs, is now 27½ cents per dozen by the year; whereas, seven or eight years ago it was only 24 cents a dozen. With such a constant stream of eggs coming into these New England States from outside, and a constant stream of cash going out of those States to pay for the eggs, it is certainly

a fair question to ask, why these eggs are not produced at home, and this money kept in our own pockets? The eggs certainly could be produced here if the farmers will but give the business the attention it deserves, and I say without fear of successful contradiction that the egg-poultry farmer will make double the profit from his business, with the same business methods, that he can make from any other branch of agriculture. An excellent proof of this I found on two farms which I recently visited in New York State. One was owned by a man who bought it without having a dollar in his pocket with which to pay for it. He had been brought up on a farm, but being of mechanical tastes learned the machinist's trade, and worked at that business for several years. Being an intelligent man he realized, after a time, that he was not getting ahead, that his weekly wages just about met the family expenses, and he longed to get back to the freedom of farm life. While in this mental condition he found an aged farmer desirous of selling his old farm, and so desirous of selling it that he was willing to take an endorsed note for a thousand dollars as a first payment of the purchase price. The man's father was able to endorse the note and loan him a little money, enough to buy a cow, a few tools and twenty-five hens. With that limited capital he started life as a farmer, but with the determination to develop that old run-down farm into an "egg farm." He bought twenty-five common hens, housed them in one of the old buildings on the place, gradually added to his stock as the eggs produced by the common hens paid for it, and had, the second year, respectable flocks of Plymouth Rocks and Brown Leghorns. From the sale of eggs produced by these flocks he saved up $75.00, and the next spring invested it all in White Leghorn eggs, and a year later had grown to a stock of one hundred and eighty good White Leghorns.

It should be observed that all of this growth had been paid for by the hens themselves. The man got his living out of the old run-down farm and garden, and laid aside every dollar of the egg money to pay for more hens, or for the buildings to put them in. Therein is the secret of his rapid climb to success. If he had insisted upon using small slices of this egg money in buying family supplies, or better clothing, or new farming tools, or other things which were sorely needed in those first years, he would not have "got there" so quickly.

There were many times when a dollar or two borrowed from that egg money would have eased the pinch of hard times in that household, but the man knew that easy times were just ahead, that the harder road was the sure one, and had the courage to wait and grow. That third year, when he had one hundred and eighty White Leghorns, eggs were scarce and high in the winter, and in January alone his flocks gave him $90.00 worth of eggs. More chickens were hatched, more buildings and yards built, all paid for out of that egg money, and for the last ten years that farmer has been selling three thousand to four thousand dollars' worth of products a year from that old farm. The hens have done it all. The total capital was the few dollars paid for the first common hens. All the rest is accrued earnings of the hens themselves.

Isn't that a cheering example? Certainly we can consider that man a typical egg farmer. His farm is all paid for, was paid for by the hens; the buildings to house them in, the fences built to enclose the yards, the hundreds of young fruit trees set out in the yards, together with the cows, farming tools and machinery for carrying on the sixty-acre farm, have been paid for by the hens; and we know there is a comfortable balance in the bank to the credit of that farmer.

Compare that condition with the one of fifteen years ago when the weekly wages barely paid the family expenses. That man loves his farm, and takes pride in his prosperous looking, clean cultivated fields, but he says his farm as a farm doesn't pay any profit. He keeps six or eight cows and makes butter for market, but says there is no money in it. He says he keeps cows and cultivates his farm for the pleasure there is in it, but the profit all comes from the hens, and he is now keeping about six hundred head of laying stock; and the eggs they produce, together with the fruit sold from the thrifty fruit trees on the place, the sale of breeding males and other surplus stock, bring up the sales to from three thousand to four thousand dollars a year.

The other farmer, whom we consider an excellent example, began life on a farm, the oldest son in a large family; and he told me of his vivid recollection of the pinching times during the war, when his hard worked father could with difficulty get enough money together to buy a sack of flour. In early manhood this young man began to teach school winters, and

continued that additional work for about ten years. In company with one of his brothers he bought a farm and started dairy farming, the making of butter being the principal farming industry in the section of New York where he lives. The money which he earned by teaching school winters was very necessary to help pay the annual interest and taxes, and without that help they would have found it difficult to make both ends meet. As they kept a careful itemized account of every cent produced on the farm they learned at the end of the year that their hens had paid them better than their cows. They kept a few hens, just as every farmer does, and at the end of the year found that their twenty-three hens had netted them over a dollar a piece profit. The next year they increased to thirty-five hens, and again the account showed the substantial profit of over a dollar a piece. This set them to thinking. If thirty-five hens will bring in over $35.00 cash profit, why will not one hundred hens bring in over $100.00, why will not two hundred hens bring in over $200.00? Being intelligent, energetic men, to think was to act. They introduced more Leghorn blood into their flocks, increased the number to about sixty, gave them better care, and found at the end of that year that the sixty fowls had brought in about $180.00 gross income. That $180.00 was a great boon, as well as a great encouragement. They had raised a goodly number of chickens, and went into the succeeding year with about two hundred head, finding at the end of it an account which showed fully three dollars income from each one, and from that instant they were confirmed poultry farmers, and went on increasing their business until their sales now average $4,000 a year in poultry products. They keep cows too, and sell milk to the creamery at a cent and a half a quart. They have just built a magnificent barn, with silo attached, which cost them about three thousand dollars, and they told me laughingly, that the hens paid for it all, that the cows never could have built such a barn as that; and certainly with milk at a cent and a half a quart we think they were right.

I have dwelt at length upon these two cases because they are typical of what any energetic, intelligent farmer can do. With the great advantages of our New England markets, it is possible for any man to make a yearly profit of from two and a half to three dollars upon every hen kept, and it is my purpose to tell you, briefly, some of the steps necessary to

produce that result. If rightly handled, hens will lay from one hundred and fifty to one hundred and seventy-five eggs in a year, and as our average price for the year is about twenty-five cents a dozen here in New England, our hens should produce from $3.12 to $3.87 worth of eggs alone. Sell her to market before she moults and you add fifty cents more to the gross income, making $3.62 to $4.37 for each hen. Deduct $1.25 for cost of food, and we have the comfortable profit of two and a half to three dollars for each hen.

There is one fact which should be constantly kept in mind, and that is, that it is the winter eggs that pay the profit. The price of eggs rises through six or seven months in the year, reaching its highest point about Thanksgiving and Christmas time, then gradually falls away again until about the first of May; this rise and fall of price being very much like the rise and fall of the tide, and quite as regular. It being a well understood fact that the winter eggs pay the profit, the method of obtaining those winter eggs is the keynote to the situation. As a matter of fact, it may with perfect truth be said that the winter eggs are all profit, because the fowls have got to be fed in winter whether they are laying or not; hence, if they are so fed that they lay, the eggs that they produce are practically all profit. The same idea holds with cows. A cow has got to be fed in winter whether she produces milk or not. If she is producing milk, that milk is practically all profit, the cost of her food having been paid to keep her in good condition for the spring; and it is precisely so with our fowls. It being a conceded fact that the winter eggs pay the profit, the method of obtaining those eggs is the keynote to the situation.

It is the pullets that we must look to for eggs in winter. The old fowls stop laying at the time of the moult in the fall, and as a rule do not begin laying again until towards spring, or if they do begin laying, lay very sluggishly, only now and then an egg; hence, a profitable supply of eggs can only be depended upon from pullets. I am well aware that some of the pullets do not begin to lay until towards spring also, and therein is another point for careful consideration. In order to get pullets to lay in the fall and have them produce a goodly supply of eggs all winter they must be early hatched, and rightly handled. One of the great difficulties with the average poultry to-day, is that the chickens are not hatched

until June or July, and do not reach laying maturity until well towards spring in the following winter, and then those late maturing pullets want to lay vigorously during the spring when we want setters, and that means more late hatches, and another generation of late maturing and late laying pullets.

One of the most common complaints which I hear from would-be poultry-raisers, is that their hens do not sit early, and in that fact we get a clue to much of the unprofitableness of the poultry raising of to-day. It is exactly like a row of bricks which every boy has played with from time immemorial, they being set up on end, just far enough apart so that when one falls it reaches and pushes down the next one, and so on until the entire row is pushed over. The late maturing and late laying pullets of this year means late breeding birds next spring, and consequently more late hatched chickens to mature late next autumn, and not begin to lay until late another winter; one season lapping over upon and crowding another; those late maturing birds producing the bulk of their eggs at a time when everybody's hens are laying, and eggs can hardly be sold at a price at which they pay any profit.

The converse of this is equally true. Early hatched pullets, got to laying before cold weather and kept laying, will be abundantly broody in March, which enables another supply of early hatched chickens, the pullets of which will be laying before cold weather comes on, and lay freely all through the winter; giving us another generation of early brooders, and more early hatched chickens. So true is this that I have come to believe that the whole story of profitable poultry raising can be summed up in three short rules.

First. Hatch the chickens early.

Second. Keep them growing so the pullets shall come to laying maturity before cold weather.

Third. Keep them laying by good care and good food.

The whole secret of keeping poultry profitably is summed up in those three short rules, and all that I have been able to learn in twenty years of careful study of the subject is concentrated into them.

When I say hatch the chickens early I do not mean too early, because there is such a thing as overdoing it. Pullets hatched too early will frequently begin to lay before the sum-

mer is over; and then will almost certainly moult in October or November, after which they are about as profitless as old hens. The first of April is the best time to hatch chickens for fall and winter layers. If I could have all of my chickens hatched in one week, it would be the first week in April. As that, however, is difficult, the hatching period is extended somewhat in each direction, so that we hatch the last week in March, and the first three weeks in April for our winter layers. If one is carrying on an egg-farm, pure and simple, using only the Mediterranean varieties, the first half of May will be the best time in which to hatch them.

On my farm I prefer what are called the American varieties, the Plymouth Rocks and Wyandottes, which are excellent layers and the best for market poultry; hence, the first part of April is our best hatching time. I believe that we in New England get the best of all-round results by combining eggs *and* poultry. For this reason, one-half of the chickens hatched are cockerels, and go to market when they are of marketable size; hence, the income to be derived from them is a factor for consideration. Not only do the cockerels go to market, but all of the hens likewise; so that, when considering an all-of-the-year-round business, it is wise to remember the income from the sale of market poultry as well as the egg income, and for that purpose the American varieties, the Plymouth Rock and Wyandotte classes, give the best results.

I gave as the second of the rules for getting eggs in winter, that we should keep the chickens growing so that they should come to laying maturity before cold weather overtakes them. A most important factor in steady growth is sweet, wholesome food. Feed often, and feed but a little at a time, is the rule with young chicks. Every two hours between daylight and dark is none too often, and see that no food is left standing in the sun to sour. Remove all of the food that remains uneaten ten or fifteen minutes after feeding. Nothing causes more bowel looseness and dysentery in little chicks than sour food.

On my farm the chief foods for the first six weeks are coarse oatmeal, slightly moistened with sweet milk if we have it; and waste bread from hotels and restaurants, which is thoroughly dried and ground to coarse crumbs in a bone mill. The first food, early in the morning, is the bread crumbs slightly moistened with sweet milk or water. The second is oatmeal moistened as before. The third, bread crumbs again.

The fourth, oatmeal again, and the last food, towards night, is of cracked wheat or cracked corn, usually alternating them, one one day, the other next. This ration is continued until the chicks are about six weeks old, when they are weaned from the mother hen, or taken from the brooder, and put out in families of twenty-five to thirty in coops in the grassfield. Fresh, cool water is kept constantly accessible to them, and the water dishes are carefully cleaned every day. Grit to grind the food is another necessity. Don't think for a moment that the chicks can find this themselves. That is one of the most common mistakes in rearing chicks. It is almost certain that the ground about our dwellings, where the chicks usually run, is practically barren of sharp gravel; hence, an artificial supply of that necessity must be provided. I have come to be such a firm believer in grit, that I now mix a small proportion of fine grit, which is commonly called "chick size" of grit, with one of the daily feeds during the first weeks, then the chickens are certain to get some of it. After the chickens are separated from their mothers, and put out on the grassfields, we usually feed them but four times a day, giving them, instead of the bread crumbs in the morning, a feed of mixed meal, which is equal parts of corn meal, ground oats, shorts, fancy middlings, (or red dog, as it is called in some localities). To this we add about ten per cent. (or one scoopful in ten) of meat meal, or beef scrap. This mixture is moistened with sweet milk or water, care being taken that it is only so much moistened that it will be crumbly, not a soft mush. The second feed, just after the middle of the forenoon, is the coarse oatmeal mentioned above; early in the afternoon, a light feed of cracked wheat is given them, and towards night a feed of whole wheat or cracked corn, one on one day, the other the next. Twice a week we have fresh meat (butcher's trimmings), cooked and chopped fine, which is mixed with the coarse oat meal for the second feeding. We have also a bone cutter, and on two days in the week the chicks have a good time wrestling and tumbling over each other in their eagerness to get the fresh cut bone; the cut bone taking the place of one of the regular feeds.

Our coops have no floors, the chicks resting upon the ground, which we think is the best plan if the ground is dry. With naturally damp ground, board floors are a necessity, and coops which have board floors must be carefully cleaned at

least three times a week; every day would be better. Our floorless coops are easily cleaned by removing them to a fresh bit of ground every other day.

As we hatch and raise chickens for the purpose of getting pullets for layers, naturally the pullets receive our consideration, and as the cockerels are a "bye" product, we separate the cockerels from the pullets as soon as we can tell them apart, shut the cockerels up in fattening pens, and send them off to the market at the earliest possible moment; our intention being that the pullets shall have the best possible chance to grow. That being our intention, the coops of pullets are scattered out in the grassfields, directly the grass has been cut off, and given full range and every opportunity to grow. Three to four months of this handling will bring them well forward, and we frequently have pullets that are thus hatched and cared for, laying by the last of September, and it is our intention to then bring them into the houses, which are to be their permanent quarters, early in October. From that time they are fed for eggs. We feed fowls three times a day the year round, feeding a cooked mash in the morning, barley or oats at noon, and wheat at night, feeding corn very sparingly, one or two nights in the week only during cold weather. Wheat is the best grain food we have, and barley the next best. Oats is a good food, but somewhat fattening; hence, should be fed sparingly to fowls that are well fed. Our morning food five mornings in the week is a mash made up of about one-half cooked vegetables, mashed fine, or cut clover cooked by being brought to a boiling heat in water, and into this is stirred a mixed meal until the mash is as stiff as a strong arm can make it; in other words, until it is stiff and crumbly.

The mixed meal consists of one part each of corn meal, shorts, fine middlings (or "red dog"), ground oats, and meat meal thoroughly mixed; we consider the thorough mixing of these meals a considerable factor in making a good mash. When we have an abundance of cut bone to give the pullets two good feeds a week, we use about half this proportion of meat meal in the mash. When we haven't the cut bone, we feed the meat meal, as I have described. The foundation of the mash is cooked vegetables, which may be potatoes, beets, carrots, turnips, onions, anything in the vegetable line, and into the pot goes the table waste, potato parings, apple parings, etc., from the kitchen. These vegetables are thor-

oughly cooked, mashed fine, a little salt added, one or two days in the week a teaspoonful of Sheridan's Condition Powder, and the mixed meal is stirred in until it is stiff and firm; then it is covered and set away to cook in its own heat until cool. Clover-rowen makes an excellent foundation for the mash, and two or three days of the week we use this instead of the cooked vegetables; intending that the mash shall be about half clover or half cooked vegetables. This mash, it will be noticed, contains quite a variety of food elements, and this variety we consider a quite important factor. A fowl needs a variety of food to supply her various physical wants and give her a surplus out of which to make eggs, and this variety of foods we believe we can best obtain in the manner we have described. A green food, especially in winter, is another necessity. Cabbage is the best green food, but anything in the vegetable line is good, and greatly relished by the fowls. An excellent way of feeding cabbage, is to hang a head of it about two feet from the ground, or floor, and let the fowls jump for it as they want it. This promotes exercise, and exercise is an important factor.

Next to the food ration, and of equal importance with it, is the housing of the stock. Elbow room is the most important consideration. That "two is company, and three a crowd" is eminently true of poultry. I believe in eight to ten square feet of floor space for each fowl kept. On my farm I have two styles of poultry houses; one has pens twelve feet square, giving one hundred and forty-four square feet of floor space to each, and we put about fifteen birds in each pen. Each family of fifteen birds has an outside run one hundred and twenty-five feet long and twelve feet wide; which gives, practically, one hundred square feet of yard room for each fowl. We have found that with this size of yard or run, we can keep grass growing green all the growing season, which greatly simplifies the green-food problem in summer. Having a grass run the fowls can help themselves to all the green food they desire. If the grass run is not obtainable, the next best thing is to spade up or plow up the ground in the yards, two or three times each summer, and sow it with rye or oats, the spading or plowing turning under the droppings and disinfecting the ground. Yards filled with the droppings are obnoxious to the birds and injurious to their health, which is unfortunate if eggs are wanted.

The other style of house on my farm combines a scratching shed and roosting pen under one roof. That house is built in sections of eighteen feet long by ten wide, the roosting-room (or bedroom, as it may be called), being a closed apartment, eight feet by ten feet, and the scratching shed being ten feet by ten feet. This house we built seven feet high at the front and four feet high at the back, with doors through from pen to pen and shed to shed in the front of the partitions. The scratching shed is all open-front to the south, being provided with water-proof curtains, attached to frames hinged at the top so that they can be swung up to the roof, where a hook and staple secure them. Those curtains are open day and night in spring, summer, and fall, and are kept closed only in stormy weather in winter; being closed every night, and left closed if the day is stormy. If pleasant, they are opened as soon as the sun is well up. These open-front sheds are the winter exercise-ground and fresh-air-bath. Six or eight inches of straw, or coarse hay, or leaves is thrown upon the floor of this shed, and all the grain feeds are thrown into the scratching litter, so that the birds are constantly exercising in the open air, but sheltered from the northwest winds of winter. That open-air exercise is promotive of good health, and the liberal food-ration, with these conditions, induces a good egg yield.

We have found it comparatively easy, by following this method of raising early laying pullets and keeping them laying, to get from one hundred and fifty to one hundred and seventy-five eggs a piece within a year of laying maturity; then turn the birds off to the butcher, and put other early laying pullets in their places. There is no magic about this. In fact, its very simplicity is a stumbling block to a great many. It is the simple problem of hatching the chickens early, keeping them growing so they will be fully matured and begin laying before the cold weather overtakes them, and then keep them laying; and pullets thus early hatched, got to laying early, kept laying for a year and then sold to market, will pay the owner the net profit of $2.50 to $3.00 a piece.

Here in New England it is the winter eggs, eggs laid when prices are high, that pay the cream of this profit. In proof of this I want to give you the figures of one hundred and twenty-five fowls on my farm in December and January, and then in the following April.

	Number of Eggs.	Sold for	Profit.
December,	1,626	$51.49	$37.48
January,	2,068	‹1.70	37.64
April,	2,232	27.50	13.34

The December and January eggs paid each over $37.00 profit, while April, with a larger number of eggs, paid only $13.37 profit. Everybody's hens are laying in April. Eggs are low in price, and pay but very little profit after paying for their food.

This winter profit will be better understood if I quote an experience on my farm in December, 1893. I had then three hundred and eighty fowls, ninety of them being year-old hens, and two hundred and ninety pullets. They laid, in the month of December, three thousand nine hundred and fifty-seven (3,957) eggs, which were sold to our grocer at the door, at forty cents a dozen the first week in the month, the price gradually falling to thirty-two cents the last of the month, and giving us in round numbers $130.00 in cash for those eggs. It costs me about $1.35 to feed a fowl a year, and that is eleven and one-fourth cents a month, which for the month of December would mean $42.75 for the food of those three hundred and eighty fowls; which, subtracted from the one hundred and thirty dollars received from their eggs, left me the comfortable profit of $87.25. Most farmers will admit that that is a pretty fair return for one month's care and feeding of three hundred and eighty fowls, but it should be borne in mind that that comfortable profit was planned for by hatching the chickens early, feeding them for a steady growth and early maturity, and then feeding them so that they were kept laying.

The question is frequently asked if it does not pay well to keep the hens over the second year. A great deal depends upon the object one has in view. If the object is the greatest possible profit, the laying stock should be sent to market each year before the moulting period. If we get our pullets to laying early and keep them laying, we have got the cream of their egg yield within a year of laying maturity; hence, the advantage of selling them before they moult, and replacing them with the next generation of early laying pullets. By this method the sum the old fowls sell for is added to the gross receipts, and likewise the net profits. It costs practically nothing to raise the pullets to take the place of the old stock. Half of the chickens hatched will be cockerels, and the cock-

erels will sell in the market for enough to pay for their food, and that of the pullets also; hence, it costs only the labor to raise them. This idea is a surprise to many farmers, but I have proved it repeatedly on my farm, and know that I am stating a fact. There are many other arguments in favor of raising a yearly stock of pullets for layers, such as that of the old fowls being too fat to lay, and being much more susceptible to disease. We all know that if we find a bird dead under the roost it is an old hen. Many of the minor troubles, such as scaly leg, feather pulling, egg eating, etc., are more likely to be found in old birds than in young ones; hence, all the argument for profit from poultry points to pullets for layers, and, as we are considering profit, we say unhesitatingly, early hatched pullets kept growing so that they will come to prompt maturity, is the foundation of profit. We say with equal confidence that the intelligent following of the plan we have here outlined will give a profit of from $2.50 to $3.00 for each hen kept, and I certainly think that poultry farming pays very much better than dairy farming.

The plan of the one is very similar to that of the other, the purpose being to produce eggs in the greatest abundance when they bring the highest prices, and that gives the cream of the profit. It is not, however, like some other branches of poultry raising; ducks for example, a large stream of profit one time, and no profit the balance of the year.

A poultry farm, properly managed, gives an all-the-year-round profit, a practically uninterrupted stream of eggs going to market, and during the season when eggs are low in price, and the stream of profit a small one, the additional profit of cockerel and fowls, marketed, gives a constant supply of cash to pay grain bills, and keeps up the stream of profit. By following this plan a farmer, keeping a thousand head of laying stock, can easily have a gross income of four thousand dollars a year, and a net profit of twenty-five hundred to three thousand dollars a year. It is only a question of good housing, good care, and good feeding, and a careful following of the three rules I have so frequently quoted. Hatch the chickens early, keep them growing so they shall come to laying maturity before cold weather, and then keep them laying. Therein is the whole story of profit from poultry, and of putting into our pockets a share of those millions of dollars that we now pay out for eggs every year.

Mr. Brown. Now my friend, Mr. Hunter, is not a rainbow chaser on the subject of poultry; he is a practical man; and I think he has given us some practical ideas; and the attention you have given to the paper which he has presented to you leads me to suspect that many of you have practical questions which you desire to ask him. He will remain with us for a short time, and you have an opportunity now to ask him any questions you desire upon the subject of "Poultry for Profit."

Mr. Blakeman. I would like to ask whether he considers it advisable to keep many roosters with the pullets?

Mr. Hunter. It has been determined by careful experiment that pullets will lay earlier and better without males than with them; and as eggs unfertilized will keep better than fertilized, it is wisdom to kill the surplus males.

Mr. ———. I would like to inquire if these early chicks are early enough to be available as broilers? Is the first of April early enough to come into the market on the broiler boom?

Mr. Hunter. Not to get the fancy market. The highest price for broilers comes in May, and it takes about fifteen weeks to grow a broiler; consequently, the April-hatched chickens do not get the cream of it. If you hatch them early to get that profit they will be too early for the best egg market. I have incubators and brooders and the help requisite, and it is wise to use that machinery, when we do not want it to produce layers, to be producing broilers. I shall start my incubators by Christmas to get broilers, and aim to have by the first of March 600 to 800 chickens of that kind, all of which, both cockerels and pullets, will go for broilers or roasters. About the first of March we begin setting hens, to raise laying stock, and the cockerels of that crop go to the market, for the best price we can get. It is not the cream, but it is beginning with the last of June and first of July prices; they are quite fair; prices gradually drop off; still, we want to get rid of them as quickly as possible.

Mr. Sherman. I would like to ask, as you use both incu-

bators and hens for hatching, whether you find any difference in the product — whether there is any difference in value for laying purposes, between the pullet hatched under the hen and the pullet hatched in the incubator? Now I have heard it stated that while you can get chicks out with the incubator, you have an inferior quality of chicks; you did not get so perfect birds; that the fowl-fancier did not pretend to get perfect birds out of the incubator. I would like to know your experience in that line.

Mr. Hunter. That statement is wholly untrue. You can get as good chickens from an incubator, under the right conditions, as with the hen. There are many who bungle with incubators, putting too much moisture in them, or otherwise mismanaging them, and one of the bungling methods is irregularity of heat, the heat running up and down; some bungle in sprinkling the eggs — which is exceedingly unfortunate. All of those things tend to weaken the embryo chick; and it is hatched under a disadvantage; it may be too late, or premature; either of those conditions weakens it, and, as a consequence, it is a weak chick. With the ordinary well-made incubator, and the judgment which usually goes with experience, we can hatch just as good chickens with the incubator as we can under hens. That is my experience. I think we can hatch just as good a per cent. of chickens.

Mr. ———. I would inquire whether the gentleman uses an out-of-door brooder; if so, what varieties he finds the best?

Mr. Hunter. I use an out-of-door brooder, and it is of that old form of brooder made by Mr. Rudd, which he called The Rudd Detached Brooder, but was not adapted to out-of-door use. It is similar to that, and can be used indoors or out. I have a brooder-house 130 feet long, divided into 16 pens, 8x10, and that is used for our market chicks. I will have that house full of chicks, each pen having a brooder in the center with something like 50 chickens in each brooder. By the last week in March some of these chickens will be old enough to be

weaned from the brooder, and I shall then take out the brooders, and raise them in the pens.

Mr. ———. At what age did I understand you to say you sold your pullets?

Mr. Hunter. When about a year and a half old. That is last year's pullets, March and April, go to market in August and September. We want to get them out of the way just before they molt. We begin the latter part of July to sell our laying stock. By that time, if they have been kept vigorously laying, they will be persistently brooding. When they get in that state, the poultry man makes weekly visits, and we have gathered up 40 or 50 of that class, and sell them to him. As a matter of fact, the disposition of our laying stock runs through probably eight or ten weeks in the latter part of July, August, and first of September, and they are 16 to 18 months old when they go to market. A pullet, if it is got to laying early, will lay as good an egg for hatching as a hen, and better. It is quite large. Many hen's eggs will be too large to produce the most desirable chick. It is the experience of men that the medium-sized egg gives the best results in number and vigor of chicks, and the best growers; so that we select on our farm medium-sized eggs for hatching, discarding the very large and very small. Pullets that get to laying early will be producing full-sized eggs by the first of January. We do keep a few selected old fowls for layers, but we breed from more pullets than old fowls. You will have noticed in the statement of my egg yield in 1893, I spoke of having 90 year-old fowls, and 290 pullets.

Mr. ———. In regard to Plymouth Rock and Wyandottes, which color do you prefer?

Mr. Hunter. I prefer white Wyandottes; and if the Plymouth Rock were equal in vigor I should prefer white Plymouth Rocks, for the reason that the barred Plymouth Rock has got established, and brought to the very forefront of vigorous, prolific hens. The markets prefer a breed free from

dark pin-feathers; and the white and buff varieties are the most desirable breeds.

Mr. Blakeman. Has there been any device invented, or rule laid down, for the amount of water or moisture to be applied in an incubator?

Mr. Hunter. I know of none. I think the consensus of opinion, or experience of poultry-raisers to-day is, to use very little moisture — in fact, almost none. At one large poultry farm I visited in my trips to New York State last year, they were hatching in Prairie State Incubators, and the hatches they were making at that time, August and first of September, in an incubator room wholly above ground, doors and windows wide open, so there was a complete draft through it, were without a particle of moisture, and as successfully as any man ever made, with "chickens coming out like pop-corn," as one man expressed it. They are good growers, and have snap in them. New England prefers the brown egg, but the New-York market pays a premium for pure white eggs; and we have to go to the Minorcas and Leghorns for those eggs. The marketman don't like them for poultry.

Mr. ———. Is it any advantage to sprinkle the eggs that are under the hen?

Mr. Hunter. No, sir, none whatever. If you let the hen alone she will hatch you the best chicks and give the best result. The hen that steals the nest will probably give you the best hatch of the year — and she does not sprinkle her eggs.

Mr. ———. Will eggs hatch as well where the hens are kept in small pens, as where they run?

Mr. Hunter. A great deal depends. If you give them a great deal of exercise they will hatch strong chickens. If the hen is confined, her eggs will produce inferior chicks, if any; the eggs will not be hatchable eggs — will be weak.

Mr. ———. Is the moisture on the ground in the nest stolen the cause of their hatching so well?

Mr. Hunter, No, sir. They will hatch as well in a haymow. The finest hatch I ever heard of was in a mow where the

heat from the stable was coming up. The hen hatched 31 out of 32 eggs. The marketmen prefer birds that weigh nine or ten pounds to the pair. Wyandottes come about to that figure. Marketmen tell me that birds above and below that size they dislike. They are what they call "stickers." In looking over a case of fowls, if they find a pair of Brahmas that weigh 7 or 8 pounds apiece, they know that that is a pair that will hang a long time before they can find a customer for them. Similar with small birds, meagerly supplied with meat. Probably the white Wyandotte is the best all-round fowl we have to-day. It is just the right size for the market, and picks absolutely clean carcasses, and it is a prolific layer, a strong hardy fowl, so that it seems just about right to suit the taste of to-day.

Mr. ———. Do you find the Plymouth Rocks are any more hardy when young than the Wyandottes?

Mr. Hunter. No, sir, I don't think I have.

Mr. Hoyt. How about the Indian Game?

Mr. Hunter. It is a very slow grower; it is a rather sluggish layer, and slow-growing fowl, so it does not come to maturity as fast as a white Wyandotte or Plymouth Rock.

Mr. Hoyt. There is one point strikes me. After the hen has been laying all the year — 175 to 200 eggs, and becomes all used up and exhausted, and is put on the market for eating purposes — after she is ready for molting, resting, all tired out, fever coming upon her — what is her condition to send to the market for people to eat?

Mr. Hunter. That is a very pertinent question, and still I think it is overdrawn, because if you have fed fowls for eggs, as we feed them on our farm, they are not worn out and exhausted when they come to the market. Our poultry-buyer — I sell everything alive from my farm — the buyer tells me they are the best he can find anywhere, when I sell them to him — that he gets the best price for them, and the marketmen jump at them most gladly — ask him when he is going to have some more of Mr. Hunter's fowls?

Mr. Hoyt. That is from having a good reputation.

Mr. Hunter. No, sir. It is from feeding fowls well.

Mr. Hoyt. It struck me that if a fowl was going into a molting state, and had got to setting, she would become feverish, and that carcass would not be so good for the table as it would some other time.

Mr. Hunter. We sell her before she has come to the molting period. So far as to being broody, we take her before she is broody. We go through every evening, and remove from the nest every bird that shows a disposition to broodiness, and we have coops in the corner of our roost-pen in which we put any broody birds we take from the nest, keeping them there two or three days in confinement, which will break up the broody fever. As the season advances, and the broody fever becomes more persistent, they will, when broken up, lay half-a-dozen eggs, and then begin to show broodiness again. It is at that time we get them into the market. And our marketman pronounces our poultry at that time the best he buys anywhere.

Mr. Brown. Mr. Hunter, I listened a few days ago to a lecture on geese-raising by Mr. Rankin, who is considered an authority on everything that is web-footed, I believe, and he said when establishing a colony of geese he confined them, but it was very important that he should confine them in such a way that they should not feel that they were confined. Now I understand that you confine your colonies of pullets, and I want to know if you have any trouble, after they have ranged, of enclosing them and finding them uneasy; whether any difficulty arose from their being uneasy and fretful, so you could not get good results after they had been shut up.

Mr. Hunter. Do you mean shut up in the house?

Mr. Sherman. In the run.

Mr. Hunter. No, sir. The change of location perhaps accounts largely for that. We first confine them, probably, for two days in the houses themselves, then open the doors to the pens. By that two days they have become weaned from their free range in the fields and become accustomed to their home; we then open the doors and let them in the yards, and they are kept in those pens and yards all the rest of the time they

stay on our farm. Of course, a giddy young pullet may fly over the fence, but I get the egg in the other pen just the same. When we first move them in, the first of October, we may at the end of a week find a dozen pullets have flown out of their pen; but we spend half an hour some evening getting them back where they belong. They don't seem to fret over the confinement; they seem to be well satisfied with it, and very soon settle down to laying, and give us eggs. I can raise eggs at 10 cents a dozen; and the price at my door has been 27½ cents for the last two years; which shows a profit of 17½ cents on every dozen of eggs we have sold. Of course, in April and May, when the price is down to 14 or 15 cents, there is not that margin of profit. It is the 40-cent eggs that pay the cream of the profit.

Mr. ———. I would like to ask the gentleman if he said anything about charcoal, or any form of charred material, as a portion of the ration?

Mr. Hunter. No, sir, because I use very little charcoal. I do feed a little bit. I have tried the experiment of putting granulated charcoal, about as large as kernels of corn, in the pen.

Mr. ———. I would like to give a little experience I have had. A good many years ago, in the *The Rural New Yorker*, I read an article like this: Take an ear of common corn, put it in the fire and char it, take it out, shell it off, and give it to the chickens; they will not pay much attention to it, but in a day or two they will begin to eat it. Give them that, and pretty soon they will put on red combs, and you will see how soon they will go to laying. I am a small farmer, and I took some and put on a pie-platter and put in the kitchen-oven, and roasted it into a mass of charred material. I put it to the chickens, and they gave a pick and went away, but after a while they got to like it; and that is one of the things my chickens get daily, which with proper grain, and meat, and bone food given to them they cannot help but lay. You give the hen the raw material for eggs, and she has got to produce

them, every time. As to the grain, our food always used to be corn, and nothing else. A neighbor of mine fed wheat, and got eggs. I followed, and for two years the only grain my fowls got was wheat. They produced more eggs in two years that I fed them steadily with wheat than any five years with corn. This burned corn seems to be just the thing in the winter.

Mr. Hunter. We keep crushed oyster shells in the pens of our laying fowls all the time, so the fowls can help themselves as they wish; but the cut fresh bone, which we feed them once or twice a week is rich in lime, and gives them shell-making material; so we find when we give them an abundance of good fresh bone they do not eat much oyster shells.

Mr. Gold. The Question Box has something for Mr. Hunter to answer. "How many fowls can one profitably keep who has two acres of ground to devote to the business?"

Mr. Hunter. That depends upon some other questions. I can keep 400 fowls on an acre. If our friend gives all of his two acres to the fowls, he can house and care for 800 on it. But how is he going to raise chickens to replace the 800? If he has to figure out a certain amount of space for chickens — say one acre, on which to raise chickens, he would have but one acre left on which to house his stock — and that would mean 400. By the system of housing and yarding which I recommend, I can put just about 400 birds on an acre; and that would be sufficient to answer the question.

Mr. Gold. Another question has been somewhat referred to. "What types are the best to keep?"

Mr. Hunter. I practically answered that. I should say middle-weight American varieties; and the Wyandottes are the best adapted to the present market demands, being right size, and excellent layers, and good vigorous stock, well acclimated to our climate.

Mr. Gold. "What would be the probable expense to equip such a ground as described (namely, 2 acres), expense in the way of buildings, etc.?"

Mr. Hunter. Roughly, to equip 2 acres for 800 fowls would cost about $2,000. Would depend upon the amount of work a man could do himself. For instance: If he hired a carpenter to take the lead in the work, and he himself joined with it — the ordinary man can drive nails, hand up lumber, can do a great deal of the work of building a plain house. So, if he puts in his labor, it could be built for $600 or $800 less than the $2,000 named, because one-third of the total expense would be for labor, and two-thirds for lumber, in such houses.

Mr. Gold. "What is the proper term to use in speaking of the male fowl?"

Mr. Hunter. "Cockerel," until the bird is fully matured — one year — and then "cock." A bird is not a cock until it is a year old. The female bird is not a hen until a year old, technically speaking.

Mr. Hale. I understand the gentleman, in referring to the cost of construction of the house, it would be reduced by a certain number of hundred dollars if the owner or proprietor works himself. Then I judge you allow him nothing for his wages. On the same basis of figures, is that your estimate of profit; that you do not count anything for the care?

Mr. Hunter. Yes, sir. I can take care of 1,000 fowls. If I choose to get my living that way, that is the way I get my living.

Mr. Hale. We all of us choose to get a living some way, and the labor is worth something. In the construction of these buildings, if a man works 100 days, I think he could have sold that labor somewhere else. I don't see that it reduces the cost at all, as a business proposition.

Mr. Hunter. Undoubtedly that is true.

Mr. Hale. Do you also figure in your net profits, taxes and interest, and the building, such as that? A certain per cent. on the wear and tear of the buildings?

Mr. Hunter. I did not in that estimate. Before I bought the farm I was paying rent for house and land. The interest and taxes on the farm which I bought is less than the rent I

paid before I bought it. I have got to have a house for my family. And if I charged interest and taxes to the poultry business I should want to credit the farm with the rent for a home for my family. I have had this same question asked me before, as to the cost of labor, etc. The average farmer does not figure out how much it costs him to raise a piece of potatoes, or corn, or to harvest a field of grass. It is part of his method of getting a living on the farm. And the poultry work I have described is precisely the same. Of course, it could be figured out to the last penny how many hours of work, at so much per hour, and the interest and taxes.

Another question is, as to the cost of the vegetables we raise on the farm for our fowls — cabbages, and refuse potatoes, and such things as that. I have always felt that the manure which I gave to the land was more than an equivalent. I give the hens no credit for the manure in my estimate. If I credit them a certain sum for the manure, and charge them a certain sum for cabbages and potatoes, one would balance the other.

In figuring this, I have tried to consider the average conditions of the average farmer who is working for a living. I have not gone quite so far as Brother Hale's question would lead to.

Mr. ———. Are apples good for fowls?

Mr. Hunter. Apples are an excellent food, though not very nourishing, they are an excellent corrective. I like to feed them when they are so cheap as this year. Acetic acid is good.

Mr. ———. What make of bone-cutter do you use?

Mr. Hunter. I use the Mann bone-cutter. I have three or four; but use principally the Mann, because we can cut more with it with the same amount of muscle.

Mr. ———. Did you ever know a hen to lay two eggs a day?

Mr. Hunter. Yes, sir.

Mr. ———. We have a minister who is a great poultry-raiser. He had 26 pullets and rooster, and used to bring in

26 eggs every day, and one day he brought in 27, and didn't know what to lay it to.

Mr. Hunter. I have an authentic case of 13 birds in a pen last year that two days within a week of each other, I think six days apart, laid 14 eggs. I have positive proof.

Mr. Fenn. I had three ducks that laid four eggs two days in a week; they laid three every day, and two days in the week laid four eggs.

Mr. Hunter. One duck laid two eggs. It is not very uncommon. A fowl, when at the height of her egg production, or duck — ducks begin to lay in January or February, and lay somewhat sluggishly at first, their egg production increasing until at the height of the season they will be laying an egg a day. Instances have been known of ducks laying two eggs a day, and then they gradually fall off again, and soon lay but two eggs a week, and drop off entirely.

Mr. Fenn. Is it common for ducks to lay in the fall, beginning the last of August and laying any length of time?

Mr. Hunter. No, sir. It is uncommon.

Mr. Fenn. I had a piece of sweet corn that they were fond of, and they commenced laying the last of August, and kept it up until November.

Mr. Hunter. That is unusual.

Mr. Fenn. I think some of the discouragements in farming are due to the fact that farmers do not give any credit to the food and everything that is furnished for their families. If they had a salary, they would know how much everything cost. They do not give any credit to the things produced on the farm and in the garden, and that is why discouragement comes in often. They think, "I must go into business to get $1,000," when this would not begin to cover the things used at home. Isn't it so? Is not that in the line of Mr. Hale's asking what Mr. Hunter charged for his own labor?

Mr. Hunter. That is a good point. Take, for instance, one of the examples I spoke of in this essay, that mechanic who found that his wages were just about meeting his expenses.

At the end of the year he had no money left. He says that he is now selling $4,000 worth of products off from his farm in a year. Of course, out of that he has to pay for grain, to keep his hens and cows — because he keeps cows for the pleasure of it, he says. He has house-rent, and fuel, feeds and clothes his family, and has a surplus left. He could charge so much per day for his labor, and keep an accurate system of books if he wanted to, and know exactly how much each cow or hen cost him. On my farm I have figured out I can raise eggs, year in and year out, for 10 cents a dozen, not counting labor. What I get for them is what I get for my labor.

Mr. ———. In feeding whole grain in winter, is it any advantage to feed it warm?

Mr. Hunter. I never tried it, and do not know that any careful experiments have been made on that subject. That is one of our misfortunes to-day, that so little is known. Almost everything we do is based upon theory, but none of these have been tested.

I was talking with Prof. Jordan, of the New York Experiment Station, a few weeks ago, and they are planning a series of experiments that will be of great advantage if they carry them out. One is, to take a pen of laying birds, carefully determine the laying ability of each bird, taking out half-a-dozen of the best layers and half-a-dozen of the poorest layers, and breed them for generations; breeding away from that common center — breeding one strain of prolific layers, and one of poor layers. Then they propose conducting certain experiments with foods as influencing egg production, and determining the value of such foods.

I hope we can get our friends to try such experiments at the Experiment Stations — and I wish our friends at Storrs would raise their own eggs, instead of buying them; try raising eggs, and let us know the results.

QUESTION BOX.

Mr. Gold. "Is there any way to make Jeffrey and others tell what they know about propagating the walnut and chestnut?" Here is a communication I received before I saw that inquiry, just answering that question exactly. Mr. Jeffrey had communicated to me just how he would graft a hickory. "This scion is cut as described, to drive in the hickory. First insert a plug *facsimile* of the end of the scion between the bark and wood of stock, in the cambium tissue. Then insert scion, tie and wax." Here is a scion. The brown bark is taken off one side for about one inch, and the scion is cut away to the middle on the other; and it is to be inserted just under the outside of the bark, a small hardwood stick of the exact form being used to press open the bark a little. The stock is not split in this case.

Mr. Platt. I have grafted chestnuts in that way this year, quite a large proportion of my grafting, and I lost about half of them by breakage. I found if I saved it I had to support the graft. The strength of the graft would not hold it after it had leaves on; it would break.

Rev. Mr. Meech. That is the method recommended. I have illustrated here in my work on quince culture how to cut the scion, and I never would split the stock for any kind of grafting, but would use this method of crown-grafting. As to Brother Platt's difficulty about their breaking out, if he will wrap something around the bark where the tongue of the scion goes down, it will remedy that difficulty.

Mr. Gold. Mr. Jeffrey says: "Insert the scion, tie and wax." That will hold it.

Mr. Platt. The tying does not answer the purpose. The graft breaks. It has not strength enough in itself; breaks where it is tied.

Mr. Hale. You refer to its breaking after it begins to grow?

Mr. Platt. Yes, sir.

Mr. Gold. I think if we can get them to grow we can hold them up.

Mr. Gold. "Is nitrate of soda, as usually sold in the original packages, sacks, etc., in proper mechanical condition — that is, fine enough for application to land and crops?"

Mr. Hale. Sometimes it will be found very lumpy, and other times the contents of the bag is in proper condition for spreading. Perhaps ordinarily 20 per cent. of it will be in lumps, that will have to be pounded and broken. Depends on the way it is kept.

Mr. Gold. I think Mr. Sanderson grinds it before sending it out for farm use.

Mr. ———. We always run it through a small sieve, and whatever does not pass through the sieve we pound up.

Mr. Gold. "Have those who have used machines for cutting seed potatoes been well enough satisfied with them to be willing to continue their use?"

Mr. Sherwood. Yes, sir.

Mr. Gold. I have a planter that cuts and delivers the seed, and we have had fortunate results from its use; sometimes perfectly satisfactory, and at others it was not satisfactory; and we attributed it to the fact that in the satisfactory use of it the potatoes had not sprouted; they were such that the machine did not injure the eyes at all; and that probably when the unsatisfactory condition existed, the sprouts were so large, the eyes so full, that the machine broke them off, and set the potatoes back, and they grew from a weakened source. I think a potato badly sprouted is not as good to plant as one with the eyes still dormant. What are the opinions of others here?

Mr. Fenn. I planted some that were cut by hand; and as I wanted to hasten the work I borrowed from a neighbor a machine to cut. You could see the difference almost as far as you could see the field. Those cut by hand were the best. I would say, though, that the uncut potatoes were hand-planted, while the machine-cut potatoes were planted by the

machine. I think possibly the machine planted them a little too deep. I found a great many pieces that came from the machine did not sprout, while nearly every one of those cut by hand did.

Mr. Gold. We are told that this machine will cut every piece with an eye on it; and if it cuts a piece that has not an eye on it that piece will form adventitious buds, and grow all the same.

Mr. Sherwood. Mr. Fenn says that he cut with the machine, and planted with the machine those cut with the machine, and he also cut by hand and planted by hand. Were they the same potatoes, and the same season?

Mr. Fenn. Exactly. Last year, and the potatoes came from the same lot.

Rev. Mr. Meech. I think Dr. Hexamer tried the experiment of cutting the eyes off; and there was quite a good many of the eyeless potatoes grew; which seems to accord with the theory of adventitious buds.

Mr. Gold. "Has any peach-grower present had any experience with the so-called 'Crown Knot,' which attacks young peach trees, eventually killing them?"

Mr. Hale. I have had no experience.

Mr. Hoyt. We do not have any of those troubles. I don't know what the "crown knot" is.

Dr. Sturgis. I don't know that there is any cause assigned, any more than for peach yellows. It is an abnormal growth, and manifests itself as a swelling, which at first is of a waxy nature, and finally becomes dry, and as large as a man's head. Sometimes more than one boil at the crown of the tree. The Cornell Station has recommended cutting them off; but, as far as my experience has gone, where that has been tried, the boils have formed at other places.

Mr. Hale. Is this identical with what is known as Root Knot?

Dr. Sturgis. No, sir. This always grows at the crown. I do not know that there is any cause to which this has been

attributed. They have said it was morbid growth due to some injury.

Rev. Mr. Meech. A lawsuit was in progress in New Jersey last week on this subject. A nurseryman had sold some trees, which had these knots on at the roots, and the suit was in progress.

Dr. Sturgis. I found a specimen of this on the place of Mr. Innes in Stratford. He had young trees, less than two years old, which had been attacked with Crown Knot just above the roots, and some of the trees had died, and others showed signs of it, which he would pull up, and there was a great bulge just above the root. He gave me two specimens, and I was going to bring them here. He had already communicated with the Station, and they pronounced it the Crown Knot. I neglected to bring the specimens with me. These trees came from New Jersey.

Mr. Gold. "What is the best treatment for asparagus beds?" I suppose that refers to the fungus.

Dr. Sturgis. Cutting the bushes as soon as the rust appears in September, and burning them as near the spot where they grew as possible. That is the only remedy I have seen recommended. It permeates the whole bush and must weaken it; and if it goes on two or three years without being checked it will damage the whole crop of sprouts.

Mr. Gold. "How can the Asparagus Beetle best be kept in check?"

Prof. Britton. Perhaps it is not the right thing to say "how can it best be done," because there are so many ways. It depends on circumstances. Kept it in check last year by spraying with Paris green and arsenate of lead. Also have seen hellebore recommended as good. If it is as good, I would say use it. It is probable, that in fine dust, blown upon them, it will kill most of the larvae.

Mr. Hoyt. That is one of the worst pests we have to contend with. If it only came once a year I would be willing to fight it, but it will come three times. Paris green I have

found would not kill it. I don't know what will kill it. I have tried putting on lime dust. I don't know that I have tried any hellebore, but I have tried everything I have seen recommended, almost, and never found anything effectual for that asparagus beetle.

Mr. Gold. "Have any observations been made during the past season as to the presence or spread of the San Jose Scale in Connecticut?"

Prof. Britton. I would say that the Connecticut Experiment Station has been working on the matter to some extent. I cannot say how much it has spread during the past season. We have been trying to find out where it was present in the State; of course, have recommended treatment in each case; and where the treatment has been carried out, as it is in most cases, the scale has been held in check. There may be localities we have not yet discovered where it is still on the increase.

Mr. Hoyt. Where have you found it?

Prof. Britton. In New London, near Bridgeport, New Haven, and several places around Hartford. I cannot remember the names of the places.

Mr. Hoyt. Did the trees come from New Jersey?

Prof. Britton. Most of them.

Mr. Gold. Did any of the places obtain their plants from any of the Connecticut nurseries?

Prof. Britton. Not that I know of. One place in Massachusetts had the misfortune to get it on imported stock, and the men from the Massachusetts Station went there and found it present, and measures were taken to eradicate it, and I think they got rid of it.

Mr. Hale. May I ask if it is not possible that we have magnified the danger from this scale? Can't it be held in check, with reasonable care, such as we have exercised against our other pests we are all more familiar with? Is not there more scare in relation to the San Jose Scale than is warranted?

Prof. Britton. Perhaps this may be true to a certain extent. I saw trees in New London, which were neglected be-

cause the man did not know they were affected. Apple trees which had been set 3 or 4 years were killed outright by it. If allowed to spread, probably the whole orchard in time would go in that way. I think with a reasonable amount of attention it can be held in check. One thing about it is, that it is rather difficult to notice at first, unless you examine the trees with great care.

Mr. Gold. Here is a question perhaps Mr. Hale will answer. "Is Peach Rosette prevalent in Georgia, and to what extent, and to what extent does it cover the South? Also, is it as deadly as Peach Yellows, North?"

Mr. Hale. To answer the latter end of the question first, it is a more deadly disease, because when the tree is once stricken it is always killed the same season. The disease was quite prevalent in certain sections in Georgia, notably in Griffin District, half way between Macon and Atlanta, and in some sections of South Carolina. They did practically nothing to hold it in check. Some of the trees were cut down, and left in the orchard where affected, and most of them without any care. I have been watching the district around Griffin 3 or 4 years, and the disease has not spread, but has gradually died out. There were not half as many trees that died in 1894 as 1893, not half as many in 1895 as 1894. It seems to be a disease that is not spreading. I understand in some sections of Florida it has broken out in the last 2 or 3 years, and was as prevalent last season as in Georgia 4 or 5 years ago. We were very much alarmed about it at that time; but it seems to be dying out there. But it kills the trees the first year.

Mr. Hoyt. How does it appear?

Mr. Hale. It is a little clustering or rosette of leaves on the end of the main branches — thick clustering, making a rosette $2\frac{1}{2}$ or 3 inches in diameter, with the same narrow light leaves that we get in the Pennyroyal sprout. When it strikes the tree, if in fruit, it begins to dry up and wither on the tree, and the tree will die before the end of the season.

Mr. Gold. "Is the fruit bark beetle (Scolytus regulosus) the cause of the bark cleaving off our pear and apple trees?"

Prof. Britton. It may be, in some instances, although there are a large number of bark beetles which occasionally are on the fruit trees; but Prof. Smith of New Jersey has found one or two others which are especially troublesome in that part of the country.

Mr. Gold. The cleaving off of the bark I had supposed was often the result of sudden freezing of the sap, that caused the bark and wood to separate. It seemed to attack some of the most healthy and vigorous trees, without any other cause that we could determine except that — and only in rare instances have I seen it.

Mr. Gold. "Has any person here had any experience in raising Kaffir corn?" Mr. Hoyt can tell something about that.

Mr. Hoyt. I had been reading the last year or two about Kaffir corn, about its being drouth-proof, and that such large crops were raised of it in dry seasons, when other corn dried up; so as I noticed an advertisement last spring in New York, I told my brother to get a quart of it. It was a round, little berry, about the size of white pills you see in the Homeopathic vials, and had a light blush on it. We planted a few patches of it, and it came up slowly. It got full growth in September, and when the other corn dried up that kept green. Makes no difference how dry the season is, it will keep green. This kept green and maturing during October, and by the first of November it got fairly ripe. I gathered it, and dried it, and left one pile of it on the floor where the poultry feed, and they devoured it. It is said to make excellent flour. It is good horse feed. Hogs fatten on it, cattle take to it; and they pronounce it the best poultry feed in Kansas. I don't think that our season is quite long enough for it here. Kansas is about the latitude, or Virginia.

Mr. Sherman. At the Agricultural Fair at Clinton I saw some very fine samples of Kaffir corn.

Mr. Gold. "Should a pear orchard that has been in sod

some eight years be plowed, and annually cultivated thereafter?"

Mr. Hale. I should top-dress it, and give it a good hetcheling with harrow, and run the mowing machine through it, and the next year do the same. I would not take anything off from it, but put things on. Give it a course of manure. I think when an orchard has been left in sod eight years, it is likely to become rooted near the surface, and plowing at once will break the roots and be too severe treatment.

Mr. Gold. "Is the butter fat in milk controlled by the feed, or the cow?"

Mr. Fenn. I asked Mr. Fuller, who was at the Dairy meeting at Hartford last winter, that same question, and he said emphatically "Yes." I showed him a little clipping, about an experiment to the contrary, and read it to him. He said that feeding did vary the amount of butter fat.

Mr. Gold. The opinion of the scientists, that the butter fat is not controlled by the feed, is not influenced by it, depends upon the presumption that the cow has a full and normal ration before the experiment is tried. When a cow has got all she can economically use of good food, it is useless for us to attempt to make her improve her product by giving more or richer food. She has got to the limit of her butter production. Our farming practices are so short of that, that there are very few cows whose milk cannot be improved in quality by more judicious feeding than they now have. This is the conclusion on this subject.

Mr. Gold. "What is the best Black Cap Raspberry now on the list?"

Mr. Hale. The Kansas.

Mr. Gold. Is it to be obtained abundantly?

Mr. Hale. Yes, sir; it is all over the country.

Mr. Hoyt. Wait until the spring catalogues come out.

Mr. Hale. The Kansas is well tested all the country over, and it is a strong, vigorous plant, exceedingly productive, ber-

ries large as the Gregg, and jet-black in color. It is, without question, the best.

Mr. Gold. "What is the best method of exterminating woodchucks?"

Mr. Hale. Put a little bisulphide of carbon in the hole and plug it up.

Mr. Gold. The smell of it is enough to warn him to leave. If he don't leave it kills him in the hole. The trouble with our woodchuck is, he builds along our stone walls, and he has half-a-dozen holes.

Mr. Gold. "What will prevent our quinces from being so knotty and wormy? Can Mr. Meech or some one else tell us?"

Rev. Mr. Meech. The knots of the quinces and other fruits are produced by the sting of insects, depositing their eggs in the fruit, or making incisions equivalent to those made for such a deposit. If the egg hatches, then you have the worm in the fruit. You may have a variety of worms, according to the variety of insects that deposits the eggs. The quince curculio is different from that which attacks the plum and may live through the winter in the larvae state.

(Music.)

(At 4:30 recess was taken until 7:30 P. M.)

EVENING SESSION, Dec. 17, 1896.

(Music.)

Mr. Gold. We have a few questions remaining in the Question Box, which, according to our custom, we must take up. Please answer very briefly, for it is time for us to proceed to the regular business of the evening.

Mr. Gold. "What is the cause of hay taking a brown cast in the mow?"

Fermentation, from the hay being put in rather green or damp.

Mr. Gold. "Is the Dairy Commissioner in this State also the inspector of vinegar?"

He is.

Mr. Gold. "What experiments have been tried to prevent Potato Scab?"

Dipping the potato seed in a solution of corrosive sublimate; avoid fresh stable manure; use fertilizer on new land.

Mr. Gold. "What is being done to eradicate Black Knot in cherries and plums?"

Some cut down the trees, as the surest way; others cut off the knots, as a temporary relief; and others let them remain to spread their poisonous spores, to propagate their kind through their own orchards and those of their neighbors.

Mr. Gold. "In what month in the year should cherry trees be top-grafted for best results?"

Mr. Hoyt. Just before the frost is out of the ground.

Mr. Gold. "Who has practiced in the North the planting of trees cut back, both roots and tops?"

It is the practice of planters to prune more closely than formerly, and trust to the removal of both root and branch to correspond one with the other, and hence start an even healthy growth.

Mr. Gold. "What is the best time to prune currant bushes?"

Mr. Platt. About this time, or any time before the sap gets up into them.

Mr. Gold. "Can't we get an expression of this meeting in regard to the discontinuance of the Peach Commission?"

Now, if there is a man here that thinks the Peach Yellows Commission should be discontinued, I ask him to rise up and be counted. No one rose.

Mr. Gold. The Question Box is closed, although I think some persons have taken some questions out of the box that were placed here, and that every one has not been read, and some I have missed, and some I did not miss—but it is my

opinion, that when they put in a question they took out one or two.

Mr. Brown: Ladies and gentlemen, we have with us to-night a distinguished daughter of Connecticut, who for more than twenty years has been carrying the light of our christianity and our civilization to that young empire in the far East, which so recently leaped into importance as the youngest empire of the world, conquering the oldest empire of the world. I have great pleasure in introducing to you Miss Eliza Talcott, of Connecticut, who will give you glimpses of life and scenes in Japan.

THE RED CROSS SOCIETY IN JAPAN.

By Eliza Talcott, of the Japan Mission.

Ladies and gentlemen: Before reading my paper, I want to take this opportunity to express the great pleasure I have had in meeting the members of this convention and listening to some of your discussions. On returning, as I have, from a second interval of 11 years' absence from my native land, it has been a great pleasure to notice the improvements and the advance in various directions, and perhaps I can rejoice in them and appreciate them even more than you, who have been watching them close at hand. Especially do I rejoice in everything that affects the home-life of the communities. And as I see the various energies bent towards the development of the resources of our land, I am fully in sympathy with the emphasis that is laid upon the home work. At the same time, if we study the condition of the homes of the people in non-Christian lands, and strive to put ourselves for a moment in their places, remembering the Golden Rule, to "Do to others as we would have them do to us," shall we not hear the voice of the Master saying, "Go preach the gospel to every creature;" "This ought ye to have done, and not to have left the other undone"; and shall we not realize that the field is the world, and that our Saviour is the Saviour of the world?

THE RED CROSS SOCIETY IN JAPAN.

In 1876, during a civil war in Japan, a society called the "Hakuaisha," or "Society of Universal Love," was organized for the purpose of giving sanitary aid to the wounded of both armies without discrimination. This was twelve years after sixteen nations had signed the International Red Cross treaty at Geneva, and six years before the United States, under President Garfield, tardily followed the example of thirty-one other nations and adopted the same treaty. The movement in Japan was under the exalted patronage of their majesties, the Emperor and Empress, and soon several hundreds of members were enrolled.

In 1886, the Society was reorganized as the "Sekijujisha," or "Red Cross Society." This change, which brought Japan into the circle of 39 other nations already bound by the Geneva treaty, is said to have been accomplished largely through the influence of Miss Clara Barton in conference with leading citizens of Tokyo.

The American amendment of the treaty was adopted, making the aim of the Society not only to care for the sick and wounded soldiers in time of war, but to give aid in any time of sudden disaster, as by fire, famine, earthquake, or pestilence.

After the opening of the recent war between China and Japan, the membership of the Society rapidly increased, until in June, 1896, 211,781 names had been enrolled. There is an annual fee of three en (this is, at the present rate of exchange, about $1.50 in gold), and besides this, a goodly number of persons contribute ten en yearly.

The constitution says that the honorary presidency shall be offered to a prince of the imperial family, and at the present time the president is Prince Komatsu, a cousin of the Emperor, and commander of the Imperial Guards.

Earl Sano is Shacho, or chairman of the executive committee, the other member of the executive committee being the court physician, Dr. Ishiguro.

While, in the United States, there is no recognized barrier to the use of the name and symbol of the Red Cross, and, as some one has said, we have Red Cross cough drops, Red Cross tomatoes, Red Cross whisky, Red Cross washing machines, Red Cross churns, and Red Cross dog collars, the laws of Japan forbid the ordinary use of the insignia, flags, or uni-

forms of the society. As his majesty, the Emperor, is a member of the association, no one in Japan would venture unauthorized to use the red cross as a mark or sign of any article.

During the war, physicians and nurses were sent out with each transport that carried troops to the front. To those who remembered that but little over twenty years ago, persons suspected of being Christians were required by government officials to trample upon a cross which was laid down before them, or suffer the penalty of death, it was a sight full of significance — the figure of the cross worn by numerous officials and employes of the sanitary division of the army, as well as by the officers of the society, by the nurses as they passed to and from the hospitals, and by the thousands of patients in the wards.

Early in the war, the city of Hiroshima was made the headquarters of the Japanese army, and most of the returning sick and wounded were brought there; four large temporary hospitals having been erected which, together with the permanent barracks hospital, accommodated over five thousand patients at once. At first, men only were employed as nurses, soldiers being detailed for that work; but after a few months, all the nurses that could be spared from the Red Cross Society's training schools in Tokyo and Kyoto were sent to Hiroshima, while quite a number from private training schools, besides a few untrained women, mostly graduates of Christian schools, or wives of army or navy officers, volunteered for hospital work.

There were about 150 nurses from Tokyo, and about 50 from Kyoto and vicinity, the latter being under the superintendence of Mrs. Neesima, widow of the late Dr. Joseph Neesima, president of the Doshisha University. Nearly one-fifth of the nurses were professing Christians, and those from the "Kyoto Training School," a Christian institution, won high appreciation.

A Christian captain, passing through Hiroshima on his way to the seat of war, visited the hospital where the Kyoto nurses were employed, and, after inspecting the wards, asked the hospital director which made the best nurses, the Christians or the non-Christians. "That is a difficult question to answer," was the reply, "but I will say that those Doshisha nurses are reliable." At another time, Dr. Ishiguro, who

was the superior officer of the Red Cross Society in Hiroshima, invited Mrs. Neesima and the two women in charge of the Tokyo nurses to meet him, ostensibly for the purpose of eliciting information which he might report to her majesty, the Empress. In the course of the interview he took occassion to remark that Christianity was a good thing for nurses,—that he had heard of no jealousies or misunderstandings among the Kyoto nurses.

As the war progressed, and still more nurses were needed, the governors of the various provinces were instructed to call for volunteers from the young men, and not a few Christian young men enlisted.

The patronage of the Red Cross Society by Her Majesty, the Empress, was, indeed, no sinecure. Declining to go with the Court to Hiroshima, she remained in Tokyo, preparing with her own hands lint and bandages to be sent to the camp hospitals, thus setting an example which was quickly followed by many women of the empire. She also furnished a false limb to each of the Japanese soldiers who had lost either arm or leg. Besides lint and bandages for the wounded, the Empress sent to each of the soldiers a handkerchief with the emblems of the army and navy stamped on opposite corners, while diagonally across it were stamped the Chinese characters for the words "The Light of the Country."

Made of coarse cotton, the intrinsic value of the gift was small, but it was highly prized and treasured by the recipient as a token of appreciation from his beloved Empress.

In the summer of 1895, the Empress took the long, fatiguing journey of over five hundred miles to Hiroshima, solely for the purpose of visiting the hospitals, and personally offering sympathy and thanks to the soldiers who had risked their lives for their country.

The spirit of the Red Cross Society pervades the army regulations. On the breaking out of hostilities between China and Japan, Count Oyama, Minister of State for war, issued a notification to the Japanese army, of which the following is the substance. (Count Oyama is not a professing Christian, but the Countess Oyama was Miss Yamakawa, who was for some years a member of Dr. Bacon's family in New Haven. She graduated at Vassar college and is a Christian woman. Doubtless, her husband has felt the influence of her Christian character.)

"Belligerent operations, being confined to the military and naval forces actually engaged, and not being conducted against individuals, the common principles of humanity dictate that succor and rescue should be extended, even to the enemy's forces who are disabled by wounds or disease. Japan became a party to the Red Cross Treaty in June, 1886, and her soldiers have already been instructed that they are bound to treat with kindness and helpfulness such of their enemies as are disabled. China, not having joined the Treaty, may subject sick or wounded Japanese soldiers to merciless treatment. Against such contingencies, the Japanese troops must be on their guard. It is not alone to those disabled by wounds and sickness that merciful and gentle treatment should be extended; similar treatment is also due to those who offer no resistance to our arms. Even the body of a dead enemy is to be treated with respect. Japanese soldiers should always bear in mind the gracious benevolence of their August Sovereign, and should not be more anxious to display courage than charity."

When, a little later, Count Oyama took command of the "second army" dispatched to China, he issued a second notification to the troops, from which the following is an extract: "Our army fights for the right in accordance with the principles of civilization. Our enemies are the military forces of the country with which we are at war, not the individuals of that country. Against the forces of our foe we must fight with all our resolution, but as soon as any of his forces surrender, are taken prisoners, or receive wounds, they cease to be enemies, and it becomes our duty to treat them with all kindness."

While there may have been rare instances where the Japanese soldiers, being exasperated by the treachery of the Chinese, violated these instructions, yet it is well known that wherever they went, nothing was taken without compensating the owner. This was in marked contrast with the conduct of the Chinese soldiers, so that everywhere the latter were dreaded by the Chinese people much more than were the Japanese soldiers.

The work of the Red Cross Society on the field was most favorably commented upon by all who visited the army. Rev. T. Honda, an earnest Japanese Christian minister, and president of a large Methodist college in Aoyama, Tokyo, was one

of eight prominent Christian preachers sent by the united efforts of all the Protestant Christians in Japan, to visit the Japanese army. He wrote of the camp hospitals in Manchuria, "As to sanitary arrangements, each battalion had two doctors and several male nurses. The nurses took up the wounded at the front and carried them two or three hundred metres back where was stationed the sanitary division with its several doctors. Far in the rear of this, where there was no danger, the field hospital was located, to which patients were sent from the sanitary division. When the army remained in a certain place for a considerable length of time, the field hospital was converted into a camp hospital. The first hospital we visited was that of Haicheng, which had over eight hundred patients. Most of them were suffering with tetanus. They were well supplied with medicines and surgical instruments, but the buildings were very imperfect. A great many buildings were required, each separated from the other. Many nurses were also necessary, and altogether the work of the physicians was cumbersome, and took much time, yet, as battle-field arrangements, we could not help admiring their perfection.

" It is a great pleasure to know that the Red Cross hospitals were especially satisfactory to the soldiers.

" I saw the Red Cross hospital in Yankow, established by the foreigners residing there, in co-operation with the surgeons of the men-of-war lying in the harbor. A large hotel was used for their purpose, which gave them a great advantage over that of Haicheng, but the hospital was not well ordered, and what attracted our special attention was the fact that the clothes of the patients were not changed. However severe the cases were, the patients wore their old filthy uniforms, many of them stained with blood. Nor was there a sufficient supply of instruments and medicines. A foreign surgeon told us they were much hindered in their work by the ignorance and prejudice of the Chinese soldiers, who often made their cases much worse by disobeying orders. When the Japanese army attacked that city, four hundred of those poor fellows, ignorant of the principles of the Red Cross society, and heedless of the remonstrances of surgeons and nurses, got up from their couches and ran away. When I visited the city, there were about four hundred patients in the hospital. The Japanese soldiers, knowing of the society

in their own country, proved more intelligent and tractable patients."

Not only were the Japanese justly proud of the work of the Red Cross society, it met also the approval and admiration of highly qualified judges from the West who visited Japan and Manchuria during the war. Medical men and army officers have been unanimous in praise of the Japanese army surgeons, and of the Red Cross Society nurses.

An Englishman, editor of the *Japan Mail*, a paper published in Tokyo, and widely circulated not only among the foreign residents of Japan, but also read with interest in Europe and America, wrote of the Red Cross hospital in Tokyo, to which a company of Chinese prisoners had been taken for healing. The article reads as follows: "This hospital enjoys the reputation of being the best equipped institution of the kind in Asia. The laboratories, the museums, the operating theatres, the medical inspection rooms, the wards,—all are supplied with everything that science in the most advanced stages dictates. It may safely be said that the Chinese prisoners never fared so sumptuously before. They have bright, airy rooms, capital beds, excellent food, a spacious garden for exercise, scrupulous neatness everywhere, uniform kind treatment and nursing. Naturally, the men want to stay in Tokyo; they find it an ideal place. As one of our contemporaries exclaimed, 'No wonder the Chinese prisoners were dazed, and feared they were being fattened for slaughter.' This hospital is an imposing, red brick building in foreign style, situated in one of the aristocratic quarters of the city. The nurses are young women, wearing a white uniform, consisting of a large white linen apron, with sleeves, and belted in at the waist. They retain the Japanese 'tabi' or socks on their feet, and on their heads wear a mitre-shaped linen cap, with a red cross over the forehead, and they wear another and larger red cross upon the right breast.

"The surgeons in their neat uniforms, similar to those of surgeons in western armies, also wore the red cross on the left sleeve. One badly wounded Chinese soldier was carried to the hospital with sullen hate depicted on his face. At first the tender care he received made little impression upon him, until, on recovery from the amputation of a leg, he

learned that each of his comrades who had suffered a like infliction had received a false leg, a gift from the Empress of Japan. His astonishment was great, and his admiration of such generosity knew no bounds, and he became anxious not to be discharged until he, too, had received the Imperial bounty."

Occasionally, the work of American missionaries in the hospitals has been misunderstood by American critics, and somewhat exaggerated and inaccurate statements have been printed. They have been represented as connected with the Red Cross Society, while the truth is that no missionaries were at any time engaged in nursing the soldiers; none would have been accepted as nurses, had they volunteered. The Japanese fought their own battles, and nursed their own sick and wounded.

The work of the missionaries was strictly evangelistic. Visiting the patients, carrying flowers and pictures, and loaning books where venders of light literature were strictly forbidden entrance, the visitors had the satisfaction of knowing that they helped to relieve the ennui of convalescence, and to rouse hope and courage in discouraged, lonely hearts, and they felt sure that many listened to the message of a Saviour's love and ere they left the hospital were enlisted as "Soldiers of the Cross." Again and again, the soldiers begged for frequent visits, saying, "Your visits do us more good than the medicine of the physicians."

One member of the Imperial Guard, just back from the field, seemed to be dying; was too weak for more than a single word of sympathy. A few flowers were put into an empty medicine bottle and hung by his bedside. It seemed unlikely that we should see him again, but at our next visit he had rallied a little, and weeks afterward when he was about to be sent with a company of convalescents to Tokyo, he sent a postal card begging for one more visit from the missionary that he might once more express his gratitude for that first visit which, he believed, had saved his life. He had thought he was dying far from home without a friend near, when the cheering words of the visitors and the flowers left beside him brought new courage to his heart, and "since then," said he, "through you I have learned the way of Eternal Life."

A non-commissioned officer who had lost his right arm too

near the shoulder to have a false one substituted, in his weakness was refusing to be comforted, saying, "Why did I not die on the battle-field!"

The story of a Father's love which makes "all things work together for good to those who love Him" and seek for the best things, was new to him, and brought hope to his despairing heart, and gradually as he read the books which were lent him, he, too, found joy in the thought of opportunities still remaining to him of service for his loving Master.

The Red Cross Society nurses were strictly forbidden to hold any conversation with their patients, other than was necessary for their care of them, and a prudent regard for her reputation would not allow a Christian nurse to even *lend her own Bible* to a patient, but she could direct the visitor's attention to waiting or hopeful patients, and thus there came to be the closest co-operation between many of the nurses and the missionaries.

Being careful not to interfere with hospital regulations, although at first somewhat distrusted by the physicians and nurses, the missionaries steadily gained the confidence of all, and with their Japanese co-workers frequently received most courteous thanks from them. But they were in no wise officially connected with the Red Cross Society, and can by no means appropriate to themselves any of the praise which that society so justly received from both Japanese and foreign critics.

The benefit of the new impetus which the army work gave to the Red Cross Society was felt in the more recent disasters of the tidal wave on the northeast coast of the Empire.

Dr. DeForest of Sendai writes: "Into this province, 51 physicians, 37 medical students, 8 druggists, 70 female nurses, and 23 male nurses were promply sent. They established at once 7 hospitals, and distributed over 10,000 articles of clothing and household goods. They were quickly at work and were an inestimable blessing to the province. Ten thousand en (about $5,000), were sent by the society to this one province, which was not nearly so much distressed as Iwade province, just north of us. How much that province received, I do not know, but somewhat near the above proportion I fancy, though the Government Medical School being here, may have given more students to this province, and as this province has the largest proportion of

Red Cross Society membership, the Red Cross work was doubtless somewhat larger proportionately than in the neighboring provinces."

In this later work of the society, the missionaries have freely and openly joined, not as officially sent, but going voluntarily among the sufferers with funds which had been put into their hands. The Rev. J. P. Moore, residing in Tokyo, writes: "The Red Cross Society is not only doing a good work directly in helping to alleviate suffering and distress among the sick and wounded, but indirectly by recommending the Christian religion to the people. The immense popularity of the Association, the fact that it is generally known to be of Christion origin, and that a number of foreign missionaries are active in it, has served to remove some of the prejudices against Christianity with which we have to contend."

Is there not in this prompt and hearty acceptance of the principles of the Red Cross Society a suggestion that Japan has a right to claim a place among the civilized nations of the world, nay, more, is there not in the cordial and active support of the Society by the Government, and by eminent surgeons and other prominent citizens, a lesson for our own land, where the burden of such work is carried by its patient president, Clara Barton, and a few faithful co-laborers, who work and wait and pray that the nation may yet awake to its duty and privilege, and, protecting the sacred symbol it has adopted, thoroughly organize the Society, and make it the prompt and permanent medium of the nation's philanthropy, which it has become in other lands.

Mr. Brown. We will now give you some stereopticon views of scenes in Japan.

(The views were then shown.)

Mr. Brown. If there is any business that may properly come before this convention there is opportunity for it now.

Mr. Peck. I have a short resolution I would like to bring before the Convention. Last evening, in hearing the remarks of Prof. Winton in regard to the work being done at the Agricultural Station in food investigation, in exposing the adulterations sold to us as pure articles, I thought it would be

very opportune time to bring a short resolution before this Convention, which might call the attention of the public to the line of work being done there, and protect them from being — well, I think we might use the word "swindled."

Resolved, That this Convention heartily endorse the work being done by the Connecticut Agricultural Experiment Station, in examining adulterated food products and exposing parties selling the same, and that we recommend that the next Legislature provide for still further work in this line, and the adoption of more stringent measures for the punishment of offenders.

Mr. Brown. You have heard the resolution as read by Mr. Peck. What action will you take in regard to it?

Mr. Fenn. I rise to second that resolution, because I have learned something of the amount of work done in that line. At a visit I made in the summer, Dr. Jenkins said: "Don't you want to see our grocery store." I said "Yes." On being taken to the room he showed me, ranged on a tier of shelves, those articles that had been examined; and it surprised me to know the amount of adulterated food put upon the market and sold as pure. I wish I had all the data that he gave me. I consider this a gross fraud upon the honest dealers themselves, but a greater fraud upon those who purchase and consume such articles. If they were sold in the market for what they were, people could then pay their money and take their choice. But if they don't know, they haven't any means to ascertain, excepting through the work that is being done; and I heartily endorse the resolution.

(The resolution was unanimously adopted.)

Mr. Eddy. Mr. President, for three days the farmers of this State have had opportunity to listen to a varied program offered, and everything has been done to make our stay a pleasant one in the city of Danbury, and make the meeting a success. It seems at this time we should show our appreciation of the courtesies received; and, therefore, I would like to offer a resolution.

Resolved, That the Farmer's Convention (under the auspices of the Connecticut Board of Agriculture), hereby tenders sincere and hearty thanks to the railroads and newspapers for the concessions and accommodations accorded; to the orchestra for the delightful music rendered; and especially to the Mayor and citizens of Danbury for the use of the City Hall, so kindly placed at our disposal, and for all the courtesies accorded us during our stay in the city.

Mr. Brown. You have heard the resolution as offered by Mr. Eddy. What action will you take in regard to it?

Mr. Sprague. As one who has enjoyed all these pleasures and privileges, I would move the adoption of the resolution.

Mr. Platt. I second the motion.

(The resolution was unanimously adopted.)

Mr. Brown. Is there any other business proper to come before this Convention? If not, I declare this Convention duly adjourned *sine die*.

(Adjourned.)

REPORT OF THE COMMISSIONERS ON DISEASES OF DOMESTIC ANIMALS.

To the Connecticut State Board of Agriculture:

We herewith present the annual report of our work as Commissioners on Diseases of Domestic Animals, together with an account of our expenditures and the amount paid by the State for cattle condemned by this commission, for the year ending December 31, 1896.

As was reported last year there are really but few diseases existing at present among domestic animals in our State which call for our attention, and were it not for the one dread disease whose danger hovers over our herds like a menacing cloud our work would be very light. As a matter of fact we have hardly been called upon to act except for that disease, tuberculosis, during the year.

We visited Cook's Park City stables in Bridgeport early in January where there was a fatal outbreak of cerebro-spinal-meningitis among the horses, but there was nothing to be done by us. Fortunately the malady did not spread far, though nearly every animal attacked in these stables died. There were also a few cases of the same sickness in neighboring stables and a few deaths.

Another complaint which has sometimes given considerable trouble, the hog cholera, we have scarcely heard of during the year. In no instance has our assistance been asked in cases of it.

Farmers have so generally learned how to act in this disorder, to separate the sick promptly from the drove and placing them in better sanitary conditions, its dangers have been much lessened.

There remains, therefore, only to report in particular upon the fight which we have helped to wage against tuberculosis, a

battle in which the whole country is now engaged as in "a grand crusade against a common enemy."

TUBERCULOSIS.

It is not our purpose to enter in a general way into a discussion upon the subject of tuberculosis. A flood of light has been thrown upon the topic during the last few years by publications which are accessible to all who wish to investigate it. Public opinion has changed in regard to its existence and the necessity of measures to suppress it. We shall therefore confine ourselves to such phases of the subject as have come more or less directly under our own observation. We shall also be limited in great part to the disease as it exists in cattle, that is, Bovine Tuberculosis. We have in our own experience no authentic knowledge of tuberculosis in horses or sheep. We are satisfied that it is found to quite an extent among swine, since we hear of it in reports of slaughtered animals, but we have made no investigations to ascertain the extent to which it prevails in this class of animals.

CHARACTER OF THE DISEASE.

Tuberculosis may perhaps be defined as the effect produced upon the body by the ravages of a minute-living organism, the bacillus tuberculosis. It is at the outset a purely local affair, starting at that point where the bacillus begins its work in the body, usually in some lymphatic gland. Where the infection has been severe it may start at several places within the body at the same time. The first effect is an enlargement of the gland, which ceases after a time, leaving the gland sometimes only slightly, sometimes greatly, increased in size. When the enlargement comes to an end, the tissue begins to assume a yellowish color and to change slowly into a cheesy mass. Occasionally this becomes, by a kind of healing process, gritty and calcareous. Usually, however, it creeps from gland to gland or else by the giving way of the tissues it is introduced into the blood and carried into other parts of the body until the

whole organism of the animal becomes involved in the general ruin. It is a long-drawn-out disease, and as we have seen may attack any part of the body. This is contrary we know to the belief of many persons who suppose the lungs to be always affected, but such belief is wholly erroneous. All writers on the disease affirm that it may exist anywhere in the body, even in the bones, and in practice we have found it so. In one case during the year we found well-developed tubercles on the underside of the tail and in another on the shin bone.

As bearing on this point we have tabulated our observations for the last year and have noted out of 878 animals examined after being killed,

135	cases,	15.4	per cent.,	lesions	found in	Retro-pharyngeal glands.
287	"	32.7	"	"	"	Mesenteric glands.
101	"	11.5	"	"	"	Portal glands.
533	"	60.7	"	"	"	Liver.
431	"	49.	"	"	"	Peritoneum.
26	"	3.	"	"	"	Uterus.
688	"	78.4	"	"	"	Lungs.
301	"	34.3	"	"	"	Bronchial glands.
501	"	57.1	"	"	"	Mediastinal glands.
60	"	7.	"	"	"	Udder.
347	"	38.4	"	"	"	Pleura.

A somewhat curious fact touching the location of the lesions which has come to our attention is, that while they may occur in any part of the body, there is a seeming tendency for the same part to be affected in the same herd. For instance, in one herd the throat may be the part, and nearly all the infected animals be found with lesions in that region. In another herd it may be the peritoneum or liver where the tubercles are mostly located.

ORIGIN OF TUBERCULOSIS.

Where the first bacillus originated it is as impossible to say as it is to say where the first individual of any other living species came from. There is no longer, however, any doubt that these bacilli pass in several ways from one animal to

another, and when one falls on good ground, such as the various tissues of the body, it begins immediately to reproduce itself. Unless this happens, unless the living germ is introduced to the body from some outside source, we feel confident that no animal would ever be affected with the disease, no matter what its surroundings. Unsanitary quarters, improper feeding, or even inbreeding, may aggravate and spread the disease, but not unless it has been brought to them to spread; they cannot give birth to it.

We have met with one case where, in the same township, were two herds of cows kept within two miles of each other. The stables of one herd were high, light, well ventilated, and finished off in varnished southern pine, while back of the animals were hung curtains to catch anything that might otherwise in any way have spattered or soiled the walls, yet eight-tenths of these cows were found to be tuberculous. The other herd was kept in an old, filthy, underground barn, where the neighbors said the stables had not been cleaned out for years, and where manure and filth had accumulated until there were at least two hundred loads of it, but there was not a single case of disease detected. Once let it have been introduced, however, into such a place and it would probably have stricken every animal. These cattle had no disease simply because no germ had been brought to them. This much then is certain, the disease must be brought from somewhere, and it becomes a matter of great interest to inquire into the source by which it has been ushered into our herds. The matter is one to which your commission has given special attention. The result of our observations is that while we believe the disease has existed many years in our state to some degree, we are certain that it has been greatly increased during the last thirty years by the introduction of foreign cattle. At the same time we do not believe that any particular breed should, with our present knowledge, be singled out as more responsible than others. That the importation or introduction of diseased cattle into districts not previously infected with tuberculosis has had great

influence in the infection of native herds, is a fact which seems to have been proven over and over again and is of the greatest practical importance. The easy modes of transportation of modern times have made it possible to bring cattle from one country to another, or from one section of the same country to another on a scale never before known, and consequently the disease has never before had such opportunities for distribution.

PREVALENCE OF TUBERCULOSIS.

The last consideration naturally leads us to that of the extent to which the disease actually prevails among our herds. It is here that the work of the commission during the year will disclose the facts very plainly, the following table of the year's work having been prepared for that purpose:

Counties.	Number Examined.	Number Condemned.	Per Cent. Condemned.	Valued.
Litchfield, . .	4,249	419	9.9	$10,491.00
Hartford, . . .	804	228	28.4	5,885.40
Tolland, . . .	598	88	14.7	2,130.00
Windham, . .	257	66	25.7	1,462.00
New Haven, . .	136	40	29.4	991.00
Fairfield, . . .	111	26	23.4	638.00
New London, . .	75	4	5.3	105.00
Middlesex, . .	74	26	35.1	605.00
Total, . .	6,304	897	Avg. 14.2	$21,807.40

614 herds tested. 397 herds contained no disease. 35.3 per cent. of the herds examined contributed 897 condemned animals which, upon post-mortem examination, revealed 146 *very bad* cases, 640 well marked, 85 light, showing breaking down of tissue but no tubercular deposit, and 19 cases in which no lesions were discovered by the naked eye. Of the last nineteen cases, four were condemned and autopsies made to satisfy owners and commissioner that the tuberculin test was not in error; the other fifteen will be referred to hereafter (page 262).

Average valuation of those condemned, $24.47.

By an examination of the above table it will be seen that Litchfield County leads in the number of cattle examined. In some sections of this county there has been a thorough and complete testing of every herd. As a result of this it is possible that the percentage of diseased animals in Litchfield County, as shown in the table, comes nearer to demonstrating the actual prevalence of the disease in general than the percentage of any of the other counties. Although we dislike to give estimates of the probable extent of its existence in the entire state, we do not anticipate that it will fall below that of this county, especially as we are suspicious that it exists in larger percentage in those counties containing large cities. It is interesting in this connection to compare this table with that published in the somewhat noted paper of Dr. Bang of Copenhagen showing the extent of the disease in Denmark, which is as follows:

Provinces.	Number Examined.	Number Reacting.	Percentage Reacting.
Jutland,	24,064	10,414	43.3
Funen,	6,669	2,002	30.
Seeland,	10,161	5,130	50.5
Moen,	1,715	605	35.1
Lolland-Falster,	2,857	926	32.4
Bornholm,	7,835	1,588	20.3
Total,	53,301	20,665	38.7

Denmark is thus shown to be much worse off apparently than we are, though our own figures are sufficiently startling. Indeed, a deadly disease which is affecting, at least calculation, ten per cent. of the cattle grazing on our hillsides and which is dangerous to other animals and man himself, cannot be temporized with. The question instinctively arises at once,

IS TUBERCULOSIS CURABLE?

Unhappily, we have no direct evidence that it can be cured, although instances are reported where post-mortem examina-

tions show that tuberculous lesions have healed; such instances are not by any means common, and we know as yet of no remedy that will cause them to heal or check them. We may say here that desiring to aid researches which are being made upon this point, we have placed in competent scientific hands several animals which have been condemned by the tuberculin test, but which are conjectured to be incipient cases, for experimental study upon this and other points. We believe that more attention than it is now receiving should be paid to this important question. But whatever developments the future may bring forth, there is no known remedy to-day for bovine tuberculosis. How, then, are we to begin a war of extermination against this insidious disease? Plainly, since we have learned that one animal infects the others there is no way except to separate the sick from the well. To do this we must find some way of detecting the presence in apparently healthy animals of an obscure and secret malady. In advanced cases it is true the disease may be known to exist by physical appearances, but in the great majority of cases it cannot be thus detected. Some other method must be used.

TUBERCULIN.

In the preparation known as tuberculin, we have the best means yet discovered for detecting tuberculosis in cattle. It is a substance produced during artificial culture of the organisms known as bacilli tuberculosis, but it is itself sterilized and contains none of the bacilli. It is thus incapable of producing the disease. When injected into the animal there is no appreciable effect if tuberculosis is not present, but if it is, there is a rise, after a few hours, of several degrees in the temperature of the animal, which we call the reaction. This is the simple way in which tuberculin is used, but it is so efficient and its importance is becoming so thoroughly understood that the greater part of the time of your commission during the last year has been taken up in making tests for diseased cattle.

It is, perhaps, not necessary at this late day to state that all

evidence goes to show that there is no harm done to a healthy animal by submitting it to the tuberculin test. It is the unanimous verdict of your commission, based upon our constant experience, that an instance where unfavorable symptoms have developed in a well animal from the use of tuberculin is unknown to us. Moreover we have standing requests with all those for whom we have made examinations, to inform us should any such instances occur in any herd we have tested, but we have never yet received such notification. To our own conclusions we might add, if necessary, that of all practitioners who have made reports in different states and the observations of those scientific men who are conducting experimental inquiries. Dr. D. E. Salmon, Chief of the Bureau of Animal Industry at Washington, D. C. (to whom, by the way, we are indebted for all the tuberculin used by us, resulting in a very great saving to the state, although it has entailed a large amount of clerical work on the commission in filling out the reports required as a partial return for the free tuberculin), says in a letter written February 6, 1896:

"Reports received of over 15,000 healthy cattle that have been injected with the bureau tuberculin fail to indicate that in any instance the use of tuberculin caused the slightest trouble in these animals. . . . With reference to the amount of tuberculin necessary to kill a cow as compared with the amount necessary to kill a guinea pig one pound in weight, the quantity is enormous. Based on our experiments with guinea pigs, it would be necessary that a cow 700 pounds in weight should receive at one injection four and one-half gallons of tuberculin, while a cow of 1,000 pounds weight would require six and one-half gallons of tuberculin. It is, therefore, absurd to suppose that the quantity of tuberculin which is ordinarily used to test the condition of a cow should cause any injury. The injections of tuberculin could never give rise to tuberculosis, if the tuberculin is properly prepared, and in case of poisoning by the large amount indicated the death would be due to acute intoxication.

"Between November, 1894, and February, 1896, a cow at our station has received injections of tuberculin amounting all together to 2,852 cc. Her condition at present is better than

it has been at any time since she arrived at the station. In May, 1895, two cows received injections of 100 cc. each of tuberculin, the same as we send out for injecting cattle. Both cows were three to four months advanced in pregnancy at the time. Neither appeared to suffer as a result of the injection; both produced good calves, and both cows are, at the present time, in first-class condition.

"Although no experiments are recorded of work done abroad in which such large quantities of tuberculin have been injected into the animals, the reports of cases where tuberculin has been used for diagnostic purposes have indicated that this test is satisfactory, and no comments as to injurious effects from the use of tuberculin upon healthy animals have been made.

"Among others Dr. Bang of Denmark, an enthusiastic supporter of the use of tuberculin, reports the testing of over 8,000 animals, but does not mention or refer to any possible injurious effects from the use of tuberculin.

"These facts serve to show conclusively that tuberculin, in a quantity used for diagnostic purposes, is perfectly harmless."

Such teachings from authorities like Dr. Salmon, emphasized by the experience of those who have used the test, are having their legitimate effect upon the farmers in the state. Apathy, and even hostility, are changing into willingness, and often eagerness, to have their herds examined with tuberculin. The changing drift of sentiment is graphically indicated in the subjoined table which shows a steady and remarkable increase almost every month during the year in the number of cattle examined.

January,	158	examined,	41	condemned,	appraised at	$665.40
February,	278	"	70	"	"	1,383.50
March,	291	"	59	"	"	1,565.00
April,	183	"	26	"	"	498.00
May,	455	"	107	"	"	2,653.50
June,	512	"	62	"	"	1,510.00
July,	618	"	49	"	"	1,184.00
August,	602	"	61	"	"	1,641.00
September,	946	"	75	"	"	2,296.00
October,	989	"	125	"	"	3,209.00
November,	755	"	154	"	"	3,660.00
December,	517	"	68	"	"	1,541.00
	6,304		897			$21,807.40

and we have now on hand eighty-five applications, representing 1,102 animals to be tested.

These figures tell their own story of the popularity of the tuberculin test. The reliance which may be placed upon it is shown by the fact that out of 6,220 examined by us by tuberculin, five only which did not respond to the test were found by physical examination to be diseased. On the contrary, ten animals which did respond to tuberculin were not found in the post-mortem with the unaided eye to be diseased, although a microscopical examination might have revealed it. At the most, then, but fifteen mistakes. It may be true that there were others that the tuberculin or physical examination did not detect, yet we have no reason to infer that there could have been many. It is not claimed by any of its advocates that tuberculin is an absolutely infallible test, but it is certainly the best we have at present.

Out of eighty-four animals examined physically, without the tuberculin, twenty-eight were condemned, and, of these, five were found by the post-mortem examination to be free from tuberculosis, an enormously larger percentage of error than in the tuberculin examinations. Still, because tuberculin is not entirely perfect as a test and because the desirability of detecting every case of tuberculosis is so great, if we hope for the entire extirpation of the disease, we are in favor of, and believe that investigation should be carried on at our experiment stations and elsewhere to discover a method yet more efficacious if possible.

TUBERCULOSIS CAN BE STAMPED OUT.

We are not unmindful of the opposition which this assertion may meet. We have not made it unadvisedly. For, though the disease may be incurable in the individual animal, yet every member of this commission feels that his own herd can be freed from it, and what he can do others can, till the disease disappears. The effect of such a result is happily summed up by Dr. Bang, when he says, at the close of his paper, "the conquest of bovine tuberculosis promises not only large economic profits, but also the annihilation of an important source of human tuberculosis."

But it will be only by stringent measures that this condition will ever be brought about. It can come, as we have heretofore indicated, only by the complete separation of the infected

from healthy animals, and by making it impossible for diseased cattle to be introduced from elsewhere.

Your commission realized early the necessity for action along these lines, and, therefore, in accordance with the authority granted by Sec. 1, Chap. 288, of the Public Acts of 1895, have quarantined herds to which we have traced disease, and, at the present time, have several such herds under quarantine. In addition to this, when we have made examinations of herds upon request of the owner (we have no authority to make tuberculin examination except upon request), it will be seen that in the blank, the form used by the applicants, they agree to observe strict regulations to protect their own herds. The form reads as follows:

Form 7 A.

Town of..........this......day of......189 .

To the Commissioners on Diseases of Domestic Animals:

STATE OF CONNECTICUT.

I hereby request that you subject my entire herd, consisting of the following animals, to wit:......cows in milk,......cows dry, ...young stock,......oxen,......bulls, to the tuberculin test, to determine whether or not any of said animals are affected with tuberculosis.

If any of said animals are condemned I agree that I will bury them and observe the sanitary regulations prescribed by this Commission, and will not introduce into said herd any animal without having it first subjected to the tuberculin test.

And I further certify that all of said animals have been owned within this State three months continuously prior to the date hereof.

Signed,......................................

P. O. Address,............... ....

We have used special efforts to prevent the importation of diseased cattle into the state. To this end we adopted, in accordance with the Quarantine Regulations of the Board of Agriculture, the following form of permit which we have required to accompany all neat cattle that are tested before they come into the state. Upon arrival they are held in quarantine until identified and released by one of our agents.

For cattle intended for immediate slaughter, under Section 2 of Quarantine Regulations, shippers are furnished with the following:

Form No. 12. No............

THIS PERMIT

Must accompany the cattle and be retained by the Freight Agent at place of destination.

STATE OF CONNECTICUT.

COMMISSIONERS ON DISEASES OF DOMESTIC ANIMALS.

To.................................... *Consignee.*

You are hereby authorized to bring within the limits of the State of Connecticut the following neat cattle, viz............... to unload at the city or town of.............to be driven directly to the premises of Mr......................in............... there to remain in quarantine until slaughtered under the inspection of this commission or their agent.

....*Secretary.*

TEAR ON THIS LINE.

No............

FREIGHT AGENT AT DESTINATION WILL FILL OUT THIS BLANK AND DELIVER SAME TO CONSIGNEE OR OWNER.

This may certify that......Cows,......Calves,......Steers, ...Oxen consigned to.................................. were received and unloaded at.........................Station this..........day of..............189

....................Agent for................R.R. Company.

To Consignee or Owner:

Upon arrival of the above described cattle to place of quarantine, you will immediately forward this certificathe to the Secretary, GEO. L. FOSKETT, Winsted, Conn.

Must accompany the animal and be ret

STATE

COMMISSIONERS ON I

To .... *Consignee.*

In consideration of the accompanying certificate properly executed and ce the limits of the State of Connecticut the animal described thereon. to unlo Mr...................., in...................., there to remain in quar

FREIGHT AGENT AT DESTINATION WILL TEAR ON THIS LINE AND

Form No. 9a, '96. No............

CERTIFICATE OF TUBERCULIN TEST.

ORIGINAL.

(To be retained by Cattle Commissioners.)

This certificate with duplicate must accompany the animal to place of destination.

Name of owner..... ....
Town of...............................**State of**....................
Breed.....................**Age**........**Weight (approximate)**..........
Color...
Markings..
Physical condition............**Normal temp. at**.......**o'clock, P. M.**.......
Tuberculin injected on the......**day of**......**at**......**o'clock, P. M., 189**
Preparation of tuberculin used.... ....

Temperatures after injection with...... ......**Cubic Centimeters.**

4 A.M.	10 A.M. ....
5 A.M.	11 A.M. ....
6 A.M	12 M. .. ..
7 A.M.	1 P.M. ....
8 A.M.	2 P.M. ....
9 A.M.	3 P.M. ....

In my opinion the above described animal is free from tuberculosis.

... .*Veterinary Surgeon.*

I have this........day of........189 identified the above described animal and released from quarantine.

(Signed) ....**Agt.**

Commissioner on Diseases of Domestic Animals.

Freight Agent at place of destination.

CTICUT.

Domestic Animals.

Dr.... ...., you are hereby authorized to bring within ity or town of.. ...., to be driven directly to the premises of identified and released by a member of this commission or one of its agents.

...., *Secretary.*

TIFICATE (ORIGINAL AND DUPLICATE) TO CONSIGNEE OR OWNER.

Form No. 9b, '96. No.............

CERTIFICATE OF TUBERCULIN TEST.

DUPLICATE.

(To be returned to Owner.)

This certificate must not be detached from the original.

Name of owner.............. .. ..

Town of................................State of.... ....

Breed........... ... .Age........Weight (approximate)..........

Color.. ....

Markings...

Physical condition.............Normal temp. at......o'clock P. M.......

Tuberculin injected on the......day of......at......o'clock, P. M., 189

Preparation of tuberculin used...

Temperatures after injection with...........Cubic Centimeters.

4 A.M.	10 A.M. ....
5 A.M.	11 A.M. ....
6 A.M.	12 M. ....
7 A.M.	1 P.M. ....
8 A.M.	2 P.M. ....
9 A.M.	3 P.M. ....

In my opinion the above described animal is free from tuberculosis.

.... *Veterinary Surgeon.*

I have this........day of.... ...189 identified the above described animal and released from quarantine.

(Signed) ....Agt.

Commissioner on Diseases of Domestic Animals.

Notwithstanding these precautions word came to us that many cattle were being brought into the state in an illegal way. In order to insure a stricter surveillance we had recourse to the following announcement, to which, in the form of printed notices and handbills, we gave an extensive circulation:

$100.00 REWARD.

The above reward is hereby offered and will be paid, until further notice, to any person furnishing the undersigned with evidence sufficient to convict the person, party, or transportation company, who may drive or bring into this state any animal or animals in violation of the laws of this state concerning contagious diseases of domestic animals and the orders, rules, and regulations made by the State Board of Agriculture, prohibiting the introduction of animals into this state.

Said reward will be paid on final conviction.

CLIFTON PECK,
GEO. L. FOSKETT,
DUDLEY WELLS,
Commissioners on Diseases of Domestic Animals.

HARTFORD, CONN., March 2, 1896.

We, thus, practically established a police force extending all around the state. Helped by this and by the friendly spirit with which the railroad corporations have manifested their desire to work with us in controlling the illegal importation of cattle, our guard-line has become much more efficient. We are of the opinion that now this unlawful importation is confined to instances where a few animals may be rushed across the border in the darkness of the night, and we trust that by the co-operation of the farmers and those interested in protecting the state, we may soon put an end even to this. Under the present regulations the legal importations the past twelve months have been as follows, viz.:

5,674 permits have been issued; 12,571 animals have arrived.

4,024 tested cattle have been released.

7,329 veal calves and 1,218 beef cattle have been admitted for slaughter.

So much, then, is the work which your commission have been able to do in fighting tuberculosis. We have examined thousands of cattle and have erected barriers against outside infection. There is left much work for which the farmers themselves must be responsible if they wish to free their herds from the incubus of this disease. All through our report we have tried to impress and make clear the fact that bovine tuberculosis, under favorable conditions, is a highly contagious disease. Cattle affected with it may discharge in various ways from their own diseased bodies, and scatter where they may be taken up to find a lodgment in other cattle, the germs or bacilli which cause the malady. These bacilli will not multiply, however, en route from one animal to another. Moreover, the journey is not agreeable to them; it is fraught with perils, and they tend to become enfeebled or die on the way.

The first step, then, in subduing the disease must of necessity be the separation of the animals, the killing, if practicable, of infected ones, and the quarantining of suspected cases wholly apart from the rest.

The second step is the cleansing and improvement of the living quarters. Like many other evils, the wicked bacilli of tuberculosis cannot endure the glare of light. The direct rays of the sun undoubtedly kill them in a very short time; some experiments have demonstrated that they will not survive fifteen minutes direct sunlight. Whenever possible, therefore, stables should be made light, dry, roomy, and well ventilated. We are pleased to see that our farmers and dairymen are beginning to appreciate this fact and we notice a marked improvement in the last year in this respect. Yet, many, perhaps the majority, of our stables are still notably deficient in light, ventilation, and cleanliness. As to cleaning the stables where the infection has existed, there can be but one course: *it must be complete in every detail.* For in-

structions on this matter we issued the following, which is placed in the hands of every owner of a herd where disease is found:

DIRECTIONS FOR DISINFECTION.

1. Thoroughly clean the stable of all litter, manure, dust, cobwebs, etc.

2. If the mangers are old, replace with new ones; if this is inexpedient, wash them and the woodwork near the cattle with BOILING water, scrape and scrub until free from all filth.

3. Dissolve two drams bichloride mercury and four drams muriate ammonia in two gallons of water, and apply to the mangers with sponge or cloth. Care must be taken that the vessel containing this solution is not used for watering stock.

4. To every gallon of whitewash add one pint of crude carbolic acid and wash the entire stable.

Thorough compliance with these suggestions we must urge upon all who are trying to get rid of tuberculosis. Where they have not been observed we have found, as a rule, upon retest of the herd, that additional animals have become infected. We believe no herd that has been once found badly infected can safely be declared free from the disease until subsequent tests reveal no disease. We are becoming more and more convinced, as experience increases, that the common manger, may we not add some of the modern devices for watering in the manger as well, affords a convenient means to the bacilli for a quick and safe trip from diseased to healthy animals, and, therefore, are dangerous affairs. We must repeat what was said by your commission in their report last year on this point: "As an all-important precaution, each animal should be taught to occupy its own stall, and the stalls be so constructed in front that two animals cannot eat from the same manger, as we think this the most common way of spreading the disease." Our suspicions of last year have become the certainties of this, and we cannot but urge that animals be kept as much as possible from contact with each

other when shut up in stables, where the bacilli have the best chance to live.

Professor Brewer has said, "the most thorough and prompt method is the only sure and safe way of extinguishing contagious disease," and we accentuate it as the only way to get rid of tuberculosis.

INFECTION FROM MILK.

The apprehension which exists in the public mind regarding the danger of receiving the contagion of tuberculosis from infected milk seems to require that we refer to the subject before closing our report, although it is not one upon which our practical work can be expected to throw much light. That danger exists is no longer denied, but that it is sometimes overestimated is also true. The danger is evidently greatest when the udder is affected, and it is then a very grave source of danger. Fortunately, the cases in which the udder becomes affected are not numerous; our table on page 3 showing that in only seven per cent. of the animals condemned and killed by us, there was any disease detected in the udder. As to the danger existing when tuberculosis is present in the udder or elsewhere, perhaps as conservative and unbiased a summing up of the whole situation as has been made is that given by Dr. Harold C. Ernst in his report in 1891 to the Massachusetts Society for the Promotion of Agriculture, for whom he had undertaken and carried through an extensive investigation. He says, "I have presented in the preceding pages the evidence that we have been able to collect upon the point in regard to which information seems to be especially needed. This evidence is sufficient, it appears to me, to warrant certain definite conclusions, as follows:

"1. While the transmission of tuberculosis by milk is probably not the most important means by which the disease is propagated, it is something to be guarded against most carefully.

"2. The possibilities of milk from tuberculous udders containing the infectious element is undeniable.

"3. With the evidence here presented it is equally undeniable that milk from diseased cows with no appreciable lesions of the udder may, and not unfrequently does, contain the bacillus of the disease.

"4. Therefore, all such milk should be condemned for food."

The experiments of Dr. Ernst were made directly on the milk itself. Indirectly, some light is thrown upon the subject by the extent to which the disease is found to exist among calves whose food is milk.

Dr. Bang of Denmark gives his experience as to the existence of tuberculosis in different ages of the animal as follows:

	Under 6 mos.	About 1 year.	About 2 years.	Adults.
Number cattle examined,	7,630	11,313	8,921	25,439
Number reacting,	1,181	3,325	3,611	12,548
Per cent. affected,	15.5	29.4	40.5	49.3

Our own experience during the year is shown in this table:

	Under 6 mos.	One year.	Two years.	Cows.	Oxen.
Number cattle examined,	386	863	639	4,269	147
Number condemned,	16	37	57	751	36
Per cent. condemned,	4.1	4.3	9.	17.6	24.5

It will be seen from these figures that while the number of cases increases rapidly with the age of the animal, there is still a large percentage of young calves which are affected. Inasmuch as the number of calves having tuberculosis at birth is admittedly small, is is fair to assume that a large proportion of the cases are due to the milk, although it is, of course, possible for the disease to have been communicated to the calves in other ways. The evidence is strong, however, that the milk is mainly accountable. In following up the subject Dr. Bang says further: "Tuberculosis investigations have made it highly probable that the co-operative dairies often contribute to the spread of the disease. The patrons receiving in return skimmed milk for feeding sheep and swine. It is understood, of course, that they do not receive for feeding

their own milk, but a part of the mixed milk. In case the milk from another patron comes from a tuberculous cow the danger is at hand that in this manner the disease may in this way be communicated to the healthy herd. That this actually happens is proved by the common observation that all grown cattle of a herd may be found healthy, while various calves and heifers react."

This risk of feeding stock with the products of the creameries is one that we believe exists here as well as in Denmark, and we think it would be a wise and timely precaution if all such products were sterilized before being fed. We have in mind two neighboring herds that were subjected to the tuberculin test last October. No disease had ever been known to exist in either herd, all the mature animals were found to be healthy, but two yearlings, one from each herd, made the typical reaction and were condemned. The post-mortem examination showed plainly well-developed tubercles in each animal in lungs, liver, and glands. Upon investigation it was found that the milk from the cows had been taken to the creamery, and skimmed milk brought back to feed the calves.

The conclusion that milk in any degree is a source of infection with tuberculosis is so important that it must of necessity be the keynote of the campaign against the disease. A food almost universally used must be freed from even the suspicion of taking into the system along with it the germs of a disease which, the world over, is responsible for eight per cent. of all deaths of human beings.

Great as is the task of crushing out bovine tuberculosis, it can be done by "a long pull, a strong pull, and a pull altogether" of those interested. In the article of Dr. Bang of Denmark, he has set before that country and outlined the mode of procedure by which he proposes to accomplish a much more difficult undertaking. He expects to get rid of the disease by strict separation with the aid of tuberculin, of the healthy from the unhealthy animals; by keeping the condemned ones by themselves until they are disposed of; he

does not say how, but, presumably, to the butcher, and, by rearing calves which are born of the healthy animals and also those which born of infected cows can pass the tuberculin test, it being well known that calves from such cows are quite likely at birth to be free from the disease themselves. If he can do that in Denmark, where the disease seems to prevail much more extensively than here, we, with so much in our favor, especially the prompt killing and disposing forever of infected cattle, should have no misgivings as to the final outcome of our efforts.

EXPENSES.

Commissioners.

Clifton Peck,	services,	$1,835.00	Traveling,	$684.43	
Geo. L. Foskett,	"	1,435.00	"	407.05	
Dudley Wells,	"	1,456.00	"	401.31	$5,668.79

Veterinarians.

Dr. R. P. Lyman,	$843.19	
" R. S. Todd,	730.50	
" G. W. Loveland,	393.00	
" E. M. Heath,	378.95	
" E. R. Storrs,	369.00	
" John R. Bacon,	282.80	
" F. G. Atwood,	211.00	
" J. E. Gardner,	97.90	
" H. T. Potter,	73.20	
" F. S. Charter,	34.50	
" Noah Cressy,	33.65	
" Andrew Hyde,	28.00	
" G. A. Waterman,	13.00	
" M. J. Black,	5.00	
" R. E. Jackson,	4.00	$3,497.69

Miscellaneous.

Releasing cattle,	$184.68	
Stationery and Printing,	121.77	
Telegraph and Telephone,	96.76	
Ear Tags,	80.00	
Postage,	78.16	
Thermometers and Syringes,	62.08	
Typewriter,	55.75	
Legal Advice,	15.10	
Express,	15.95	
		$705.28
		$9,871.78
Less by hides sold,		$39.55
		$9,832.23
Condemned cattle,		$21,807.40
Total,		$31,639.60

CLIFTON PECK,
GEO. L. FOSKETT,
DUDLEY WELLS,
Commissioners on Diseases of Domestic Animals.

Hartford, January 7, 1897.

NECROLOGY.

EPHRAIM H. HYDE.

Ex-Lieutenant-Governor Ephraim H. Hyde died at Stafford, June 18, 1896. He was born in Stafford, June 1, 1812. With only the opportunity of the common school for his education, at the age of 21 he began business on his own account in a country store, and later engaged in manufacturing. He soon was owner of a large amount of land, and agriculture became his leading pursuit. His interest in this industry never failed. The enticements of wealth or political advancement never interfered with his devotion to agriculture, because the love of agriculture and of everything pertaining to rural life was a controlling power, and in the wide circle of his acquaintance he was best known by his agricultural friends, and in estimating his character and influence upon the State and country, we always have in mind that he was known as a friend of agriculture. Naturally endowed with a nice sense of beauty in form and color—in fruits and flowers, in orchards and gardens, in luxuriant pastures with their grazing herds, all gave him delight, and he will ever be remembered as a cultivator of the soil and a breeder of fine stock. His personal encouragement of these departments of human industry must stand as his most successful work, and that which brought him so near in heart with so many friends. His success as a breeder of Devon cattle is acknowledged.

Omitting the other public positions that he has held, we only name those connected with agriculture. The Tolland County Agricultural Society and the Connecticut State Agricultural Society, of both of which he was a long time President — member of the State Board of Agriculture from its establishment in 1866 till his death, and as Vice-President and Chairman of Commissioners on Diseases of Domestic Animals

for most of the period — member of Board of Control and Vice-President of the Connecticut State Agricultural Experiment Station from its establishment in 1877 to the time of his death. Member of Board of Trustees of Storrs Agricultural School, and Vice-President of Board from 1881 till 1895.

These long periods of official service in the cause of progressive and more intelligent agriculture indicate the character of the man, always faithful and persistent in the discharge of every duty, for the people knew that his good judgment and honesty were always at their service, and that they could rely upon his earnest performance of every charge imposed upon him. As he had nothing to conceal, his position upon all public matters was well known to his friends, and the memory of such a co-worker will always remain embalmed in their hearts. When the Grange was revived in this State Mr. Hyde became a Patron of Husbandry, placing himself in the ranks of that order which has power to do so much for all who love and practice husbandry.

Governor Hyde enjoyed a wide acquaintance outside of Connecticut. He was always treated with respect by all friends of agriculture, and it was a reasonable pleasure to witness our own State so honored by so honorable a man. All our institutions for the advancement of agriculture owe much to his indefatigable and self-sacrificing efforts in their behalf. His genial spirit and courteous manners added weight to his opinions. Such men are rare products, and we rejoice that he retained his powers of body and mind beyond fourscore years, to assist those associated with him by his counsels and labors, and to be a blessing to the age and community in which he lived.

REPORT OF THE POMOLOGIST.

N. S. Platt.

It has seemed to me that a record of some of the Pomological happenings of the year in our State might not be out of place.

If correctly given even if not complete, it might serve as a basis for future reference, if it does not impart present information.

The winter which preceded the fruiting-season of 1896 was marked by a prolonged spell of high temperature occupying the last three weeks of December, during which time the ground hardly froze. This encouraged a movement of sap, which in some trees, as that of the peach, made its effects perceptible at the time.

In January the mercury fell to 8 degrees below zero, and in February to 11 degrees below, as recorded by the signal office at New Haven.

In other places in the State, away from the influence of the Sound, the cold was two to four or more degrees greater.

This killed the blossom buds of the peach almost entirely all over the State.

One orchard in Milford yielded, it is true, 800 or 1,000 baskets, and the whole State beside probably did not yield much more. Trees which in 1895 produced 10,000 baskets did not yield one basket in 1896. A barrenness so complete I do not believe has happened with us for a generation. Cherries, pears, and plums suffered nearly though not quite so badly as peaches.

All of them gave very light crops, the European suffering with the Japanese plums this time. Apples in my locality, and in towns along the coast, were light, in other localities a heavy crop. Strawberries where not heavily covered were injured, the fruit-germ being killed or weakened, the resulting crop in most cases being a light one, and the later pickings very imperfect.

One of the enemies of fruit that has been unusually prevalent, was the canker worm.

It has existed somewhat widely in the State for years, but generally not in large numbers, and in most places it has not been thought necessary to work for its destruction. Last

spring, however, it was present in larger numbers than I have ever known it, and spraying for the canker worm became a necessity. For the best results and indeed for even a reasonable success, the spraying needs to be done early while the worms are small, and before the leaves are much eaten. Machinery should be ready, and plans laid to take them at the right time. I would use 1 pound Paris green to 150 gallons water, and as much good lime as Paris green.

The Shot Hole Fungus has been prevalent as usual on the leaves of the European plums, and I have heard that it has been found in one case working on the leaves of the peach.

This fungus yields readily to treatment with Bordeaux. Two or three good applications will retain the foliage to the end of the season.

THE BLACK KNOT OF PLUMS AND CHERRIES.

This disease also can be surely, and in most cases readily, controlled, though I am sorry to say there are some districts in the State where it seems to be alarmingly on the increase.

Five years ago I had never seen a black knot on the common wild cherry, and seldom on the sweet cherry, now in certain districts it is common on both. Cutting and burning the knot, and the use of Bordeaux are the remedies.

A little work at the beginning in clearing up all knots that can be found, whether domestic or wild, and a little more each year in the same line and in using Bordeaux, will give good and sure results. Two or three good applications of Bordeaux applied during the first half of the season will kill nearly all the spores that may alight on the trees.

The blight on the quince that kills the ends of the branches, has been prevalent also, and in some districts, particularly in Milford and Branford, it has prevailed on the pear, and what appears to be the same thing has been seen on the common wild cherry.

The Peach Yellows has been prevalent as usual, and though in Connecticut we have as yet but little that we can point to, as showing that we can stamp out the yellows, yet I have not lost courage, or my faith in the belief that we can keep it under reasonable control.

Other places have done it, and for years have reduced their losses to about one in five hundred. I think we have one case

of this kind in Connecticut, and hope soon we will be able to claim more.

This disease is as mysterious as ever, yet in treating it, one fact remains clear, and that is, that the only treatment that has given any degree of success is the one of prompt destruction. Anything short of this is no success at all. Prompt destruction does not mean getting the trees out two or three months, or two or three weeks, after it first shows. It should be closer than that, it should be just as close as can be. Neither is it safe to my mind to leave the diseased wood unburned and lying in or around the orchard. Both here and in Michigan, it has been noted that those who permitted this had trouble with the yellows, while those who had little trouble were those who kept cleaned up.

At the time of the first application of our yellows law, Prof. Brewer of New Haven, a prominent member of the State Board of Health, said at our Farmers' Convention, that in the treatment of contagious disease of the human race, only those methods which were most prompt and thorough were at all successful in preventing their spread. In fact, no other methods were worth trying; and in his judgment the only methods to be relied on at all to control the yellows, were the same that are successful in subduing diseases of the human race. I think Prof. Brewer's judgment was not at fault. Our law on this subject is a good one. It gives ample time (10 days) for the destruction of diseased trees. I wish it read 5 days instead of 10. And then I would be glad to have the law, as amended or even as it stands now, more rigidly enforced. It seems to me the time has come when it should be enforced, or it will become a reproach.

The shot hole borer of the peach which appeared in a small way about two years ago for the first time among us, has I think increased somewhat. It also preys upon the Japan plum. The encouragement about this insect is, that it seems to attack only trees that are unthrifty. At about the middle of last July I found the insects quite numerous on several injured trees. The trees which were attacked would surely have soon been dead, so the remedy I tried and the one I would recommend, was to cut and burn the trees at once, wood insects and all.

The enemies of fruit are very numerous, and the trouble we have on their account is great, yet we do sometimes have en-

couragement, as when we learn how to control the black knot, or some of the fungus tribes, also when our troubles disappear without our intervention.

Of this latter class are the soft aphides which have been disappearing for two or three years.

They are the hardest of all the insect tribe to manage on account of their wonderful powers of production, and the rapidity with which they come to maturity.

One of these, the black aphis of the cherry, has been absent from my place for two years, after having been a steady visitor each season, for twenty years or more.

This insect I believe has been the cause of the decline and death of most of the cherry trees we have lost during the last twenty years. I am glad to have it go. My young cherry trees, which have all taken on a luxuriant growth, seem happy too.

Another is the pear tree Psylla, which has been an increasing trouble for some years past. This year though there were a few present early in the season, yet they did not show up later and they left no effects. As to the cause of the disappearance of these two insects, and perhaps of the soft aphides generally, I can only conjecture that they have some natural enemy, perhaps the lady bug, which has been abundant enough to subdue them.

A new thing in connection with our last fruiting-season, was that owing to the cutting off of our own crop of peaches, this fruit was brought to us from West Virginia and western Maryland, and also from Michigan, and very good peaches they were too, better than were sent to us from Delaware. I cannot remember that they have ever been brought to us from the first mentioned places before.

Taking the whole State, and counting all kinds of fruit, it seems to me that our fruit crop of 1896 was a light one, if we except the apple in some sections. The present mild winter seems so far to be a repetition of the last one. We hope its effects on our next year's fruit crop will not be so disastrous as was that.

EXHIBITS AT DANBURY, DEC. 15, 16, AND 17, 1896.

Grain — oats in bundle, by Simon Hunt, Columbia.

Corn — Dent corn, Dennis Fenn.
" E. Mastodon, D. M. Mitchell, Southbury.
" Hebron, G. A. Chalker, Saybrook.
" Red Blaze, " "
" Imp. Canada, " "
" Beers' 8-Rowed Yellow, N. S. Platt.
" Red " "
" Brindle, "

Potatoes — 33 varieties, P. E. Cope, Meriden.

Apples — 34 varieties, from T. S. Gold, all correctly named, of good size, and free from worms, scab, and spot, including Westfield Seek-no-Further from tree over 100 years old, and clean, large specimens of Newtown Pippin and Burnham Sweet.

From Joseph Albison, South Manchester, 12 varieties of handsome apples, including the Manchester Sweet, which originated on his farm from seed of a small crab; also large, well-colored specimens of Ben Davis, grown on both light and heavy soil.

12 varieties, Simon Hunt.

1 plate Vandeveres, E. H. Ryder, Danbury.

16 varieties, N. S. Platt.

One plate of house grown oranges, from tree 70 years old, by T. S. Gold.

7 varieties of plums, 2 varieties pears, and 10 varieties of apples, modeled in wax, and very perfect in form and coloring, from Storr Agricultural College.

Products of the greenhouse, consisting of tomatoes and radishes from the Experiment Station at New Haven; also from the same station a case of bugs, beetles, caterpillars, and butterflies, of interest to agriculturists; and many samples of adulterated foods, all labeled, which they had tested and found wanting.

Copper indestructible tree labels, from Cheshire Manufacturing Co. of West Cheshire, Conn.

Cornstalk tie, made of cord and a small block of wood, from Philo T. Platt, Newtown.

Scions of chestnut, apple, and pear, by N. S. Platt.

Tuberculous specimens in jars, by Dr. F. G. Atwood of Minortown, Conn.

Butter separator, the "Little Giant," by D. D. Hawley & Son, Danbury.

Cheese — One from Mrs. D. D. Hawley, Danbury.
Sample from Mrs. W. H. Hammond, Elliott.

Butter — D. D. Hawley & Son, from thoroughbred Holstein cows.

Honey — Ella Sharpe, Elliott.

Vinegar — Sample from Simon Hunt.

Chestnut — Paragon and native, by N. S. Platt.
The new Burbank, a Japanese variety, originated by Luther Burbank, and now the property of A. J. Coe of Meriden, exhibited by J. H. Hale.

OFFICIAL LIST OF AGRICULTURAL SOCIETIES IN CONNECTICUT, 1896.

Name of Society.	President.	Secretary.	Treasurer.
Connecticut State,*	George A. Hopson, Wallingford,	W. F. Andross, East Hartford,	Eugene A. Hall.
New Haven County,†	D. N. Clark, Woodbridge,	....	Frank S. Platt.
New London County,	James A. Bill, Bill Hill,	G. L. Hewitt, Norwich,	Chas. W. Hill.
Windham County,	Chas. W. Grosvenor, Pomfret,	J. B. Stetson, Brooklyn,	P. B. Sibley.
Litchfield County,†	Harry Sedgwick, Cornwall Hollow,	D. C. Kilbourn, Litchfield,	E. C. Jones.
Middlesex County,†	J. M. Hubbard, Middletown,	G. W. Wilson, Middletown,	G. W. Wilson.
Tolland County,	Thos. A. Lake, Rockville,	F. R. Tucker, Rockville,	F. A. Randall.
Berlin,	H. E. Savage, East Berlin,	F. L. Wilcox, Berlin,	G. E. Hall.
Branford,	Geo. C. Field, Branford,	J. A. Pond, Branford,	Walter Foote.
Bristol Park Co.,	Ard Welton, Plymouth,	Milo L. Norton, Bristol,	A. L. Morse.
Cedar Valley,†	Levi S. Wells, New Britain,	John S. Kirkham, Newington,	E. F. Blake.
Chester,	Fred. S. Smith, Chester,	Charles E. Perkins, Chester,	Charles E. Perkins.
Clinton,	Edwin H. Wright, Clinton,	C. H. Evarts, Clinton,	George H. Brooks.
East Granby,†	C. H. Hanchett, East Granby,	Wilbert H. Gay, East Granby,	Clinton Phelps.
Danbury,	Samuel H. Rundle, Danbury,	G. M. Rundle, Danbury,	J. W. Bacon.
Farmington Valley,	Oliver F. Perry, V.-P., Collinsville,	E. A. Hough, Collinsville,	B. F. Case.
Granby,	Geo. Beach, Granby,	Chas. Coffee, Granby,	Lewis C. Spring.
Guilford,	Wm. S. Leete, Leete's Island,	W. A. Dudley, Guilford,	Geo. B. Spencer.
Harwinton,	John H. Reynolds, Harwinton,	Albert W. Buell, Harwinton,	Patrick Hogan, Jr.
Killingworth,†	D. K. Stevens, Killingworth,	N. H. Evarts, Killingworth,	A. B. Stevens.
Madison,†	J. Myron Hull, Madison,	J. D. Kelsey, Madison,	J. D. Kelsey.
New Milford,	A. J. McMahon, New Milford,	J. H. Cochrane, New Milford,	E. J. Emmons.
Newtown,	Theron E. Platt, Newtown,	H. C. Beers, Newtown,	C. G. Peck.
Oxford,†	W. B. McEwen, Oxford,	C. H. Butler, Oxford,	C. H. Butler.
Simsbury,	Edward A. Hoskins, Simsbury,	Geo. C. Eno, Simsbury,	Geo. C. Eno.
Stafford Springs,	E. C. Dennis, Stafford Springs,	C. F. Beckwith, Stafford Springs,	W. D. Heald.
Suffield,	Waldo S. Knox, Suffield,	Egerton Hemenway, Suffield,	J. D. Haskins.
Union (Monroe, etc.),	F. W. Wheeler, Monroe,	S. T. Palmer, Shelton,	D. S. Clark.
Union (Somers, etc.),	Myron S. Gowdy, Somersville,	H. S. Woodward, Enfield,	C. A. Thompson.
Watertown,	Wm. G. French, Watertown,	A. H. Scoville, Watertown,	Wm. J. Munson.
Willimantic,	J. Griffin Martin, Willimantic,	W. S. Crane, Willimantic,	Frank Larrabee.
Windsor,†	H. H. Ellsworth, Windsor,	E. S. Hough, Poquonock,	E. F. Thrall.
Winsted,	Geo. W. Brown, West Winsted,	E. M. Platt, West Winsted,	E. M. Platt.
Wolcott,	H. B. Carter, Wolcott,	E. M. Upson, Wolcott,	E. M. Upson.
Woodstock,	L. A. Catlin, Putnam,	H. W. Hibbard, Woodstock,	A. E. Brunn.

* No returns. † No fair.

RETURNS OF AGRICULTURAL SOCIETIES, 1896 — FINANCES — RECEIPTS.

SOCIETIES.	Cash on Hand.	Single Admission Tickets.	Membership or Season Tickets.	Grand Stand.	Donations and Unclaimed Premiums.	Entrance Fees. Trials of Speed.	Other Entrance Fees.	Rent of Grounds.	State Appropriation, 1895.	Other Sources.	TOTALS.	State Appropriation, 1896.
New London County,	$40.89	$2,535.90	$74.00	$201.50		$684.00	$17.25	$562.25	$263.45	$462.13	$4,791.87	$237.45
Windham County,	59.07	1,395.00	50.00	148.60	$85.00	815.00	58.50	307.50	283.10	164.79		297.83
Tolland County,		1,178.25	352.20	293.95		751.50	58.75	388.50	191.40	58.00		201.66
Berlin,	27.25	301.00	92.00	37.00		*87.00		27.50	127.40	195.70	794.85	130.35
Branford,	73.31	721.81				637.00	8.00	73.25	141.88	412.28	2,067.53	111.28
Bristol Park Co.,		1,001.04		78.43	128.15	†234.50	141.00	184.00	235.38	183.30		271.79
Chester,		52 00	42.00					17.00	106.92	45.60	263.52	111.28
Clinton,	27.30	99.20	34.00		19.25		2.00	26.25	115.46	110.90	434.36	119.83
Danbury,	3,875.22	10,155.72	15.00	2,289.75		1,790.00	637.71	3,717.46	919.34	252.54	23,152.74	1,159.48
Farmington Valley,	596.76	942.10		137.35		580.00	38.00	275.95	150.38	80.00	2,800.54	162.94
Granby,		497.70				295.00	5.00	95.00	105.84		998.54	105.65
Guilford,	683.02	120.79	96.50		44.00				126.14	40.84	1,110.79	135.44
Harwinton,	26.47						6.50	304.75	131.10		468.82	128.12
New Milford,	956.60	1,187.09		81.53		142.50			149.78	38.33	2,555.83	153.69
Newtown,		1,517.14		242.00	100.00	228.00	16.50	176.80		89.50	2,369.94	175.14
Simsbury,		655.10	20.00			215.00		130.00		17.55	1,037.65	187.54
Stafford Springs,	1,679.90	2,650.69	234.00	407.65	27.05	558 00	176.50	753.90	326.95	33.74	6,848.38	328.76
Suffield,	75.71	1,293.44		140.38		820.00		200.00	132.40	841.00	3,002.93	116.00
Union (Monroe, etc.),	199.26	906.30	181.00	57.75		172.00	18.50	164.75	191.10	138.00	1,973.66	195.16
Union (Somers, etc.),	1,325.61		6.00		38.00			35.00	114 05	118.48	1,637.14	128.67
Watertown,		548.40	180.00	26.25		71.50	55.50	140.20	196.10		1,217.93	239.54
Willimantic,	15.25	1,800.81	110.00	347.17		1,049.68	117.75	548.00	117.97	115.48	4,219.11	123.18
Winsted,		751.47	104 25	57.35	185.75	400.00	9.80	115.15	124.10	534.00	1,753.21	102.88
Wolcott,	827.84	162.00	50.00				7.50	62.75	154.52	115.86		171.16
Woodstock,	38.22	1,058.98	78.00	155.73	1.48	91.50	63.05	226.25	278.45	140.66	2,132.37	273.95
Connecticut Hort. Society,	15.72	240.50	258.00						196.92	358.20	1,069 34	187.13
Connecticut J. C. B. A.,									100.00			181.36
Conn. Dairymen's Associ'n,	309.21		94.00						1,144.31	164.00		1,163.15

* Bicycles. † Horse and Bicycle.

RETURNS OF AGRICULTURAL SOCIETIES, 1896 — FINANCES, CONTINUED.

SOCIETIES.	Expenses of Fair.	Premiums for Speed and Amusements.	Other Premiums and Gratuities.	Permanent Improvements.	Other Expenses.	Cash on hand.	TOTAL.	Indebtedness of Society.	Real Estate.	Personal Estate.	Number of Members.	No. of Stockholders —Joint Stock.	Capital Stock.	Estimated Attendance.	Admission Tickets.	Season Tickets.	Grand Stand.
New London Co.,	$1,330.38	$1,565.50	$713.72	$60.25	$1,048.25	$73.27	$4,791.87	$5,950.00	$10,000.00		243			7,700	$0.35	$1.00	$0.25
Windham County,	566.96	1,042.20	982.00	179.92	63.92		2,835.56	400.00	4,000.00	200.00	710			4,500	.85	1.00	.20
Tolland County,	846.82	1,660.85	553.90	144.93	138.00			2,500.00	4,000.00		400			10,000	.85	1.00	.25
Berlin,	230.17	93.04	235.50	151.10	84.80	.24	794.85	276.75		500.00	92			1,200	.25		.15
Branford,	634.66	1,075.50	150.37	205.00		2.00	2,067.53	100.00			75			3,500	.25		
Bristol Park Co.,	428.40	617.75	867.05	100.81	145.00		2,159.01			10.00				4,300	.25&.15		.10
Chester,	84.20	10.00	150.40		13.63	5.29	263.52				168			1,000	.10	.25	
Clinton,	180.40	21.00	188.50		5.09	39.37	434.36				79			2,500	.10		
Danbury,	11,031.27	3,648.80	4,830.55	1,833.40	1,200.00	608.72	23,152.74		12,000.00	3,000.00		297	$12,000.00	50,855	.25	5.00	.25&.15
Farmington Valley,	417.26	1,020.00	881.06		422.74	559.48	2,800.54	3,400.00	9,203.07			78	5,000.00	8,400	.25		.10&.50
Granby,	85.00	700.00	125.25	850.00				644.26	2,350.00	50.00	88			2,300	.25		
Guilford,	34.82	68.00	258.25			749.72	1,110.79			100.00	193			8,000	.15	.50	
Harwinton,	210.86		225.55			32.41	468.82			189.71	112			7,500			
New Milford,	788.34	407.00	339.75		125.00	895.74	2,555.83							5,000	.25		.15
Newtown,	182.52	658.00	435.50		420.17	673.75	2,369.94	1,500.00	2,000.00			98	3,000.00	7,500	.25		
Simsbury,	51.25	660.00	267.62	108.95				450.00							.25		
Stafford Springs,	1,647.00	1,734.50	1,121.44	309.51		2,035.93	6,848.38		6,700.00	300.00		109	*5,000.00	10,000	.35	1.00	.15&.25
Suffield,	706.04	1,365.00	171.45	134.50	441.09	184.85	3,002.93	1,094.00	4,500.00	50.00		351	3,255.00		.35		.15
Union (Monr'e, etc.)	749.23	400.00	524.88		150.00	149.55	1,973.66	800.00	1,200.00		131			4,173	.25	1.00	.15
Union (Somers, etc.)	119.68		228.00			1,289.46	1,637.14				364			5,000			
Watertown,	423.63	365.02	723.05	238.47				1,700.00	7,500.00	50.00		157	7,000.00	4,000	.25	1.00	.15
Willimantic,	1,118.16	2,301.25	203.50	550.00	595.21	.99	4,219.11	400.00						10,000	.35	1.00	.25
Winsted,	681.91	1,119.35	112.87		189.74		1,753.21	4,000.00			67		4,000.00	1,720	.25	1.50	.10
Wolcott,	173.35		417.75				789.35			100.00	50			1,000	.25 &.10	1 00	
Woodstock,	391.16	310.00	876.73	171.04	350.78	32.66	2,182.37	1,850.00	10,000.00		498			5,220	.25	1.00	.15
Conn. Hort. Soc.,	503.65		489.50			76.19	1,069.34	506.00		1,325.00	197			2,000	.10 &.25		
Conn. J. C. B. A.,																	
Conn. D'r'n's Asso.,										100.00	124						

* Paid in $2,000.

ANALYSIS OF PREMIUMS AND GRATUITIES PAID.—FARM STOCK.

SOCIETIES.	Bulls.	Milch Cows.	Heifers.	Calves.	Working Oxen.	Steers.	Fat Cattle.	Horses, except Speed.	Horses, Speed.	Sheep.	Swine.	Poultry.	All other Stock.	TOTAL.
New London County,	$62.25	$261.50	$25.75	$26.75	$41.50	$10.00	$8.00	$129.25	$1,307.50	$153.25	$35.50	$38.50		$2,094.75
Windham County,	66.50	87.50	66.00	19.00	28.00	15.00	12.00	179.00	835.00	30.00		19.00		1,357.00
Tolland County,	6.00	22.00	6.00	1.50	46.00	4.00	4.00	51.00	1,191.10	6.00	8.00	110.75	$6.00	1,412 35
Berlin,	6 00	24.50	2.50	4.75	7.00			23 00		4 00	7.00	27.00	3.00	108.75
Branford,	1.00	3.50	1.50		19.50		1.50	9.00	1,050.50			10.87		1,097.87
Bristol Fair Corporation,	27.50	48.00	18.00	3.50	55.00	13 50	1.00	60.00	450.00	18.50	12.00	135 00	22.00	859.00
Chester,		2.00			4.50	1.00		10.50			9.00	2.00	3.90	32 90
Clinton,	1.50	8.00	5.00	6.50	14.75	3.00	1.50	9.75		9.00	18.50	19.75	7.00	99.25
Danbury,	239.00	207.50	132 00	38.50	137.00	44.50		446.50	2,710.00	171.25		254.75	966.00	5,347.00
Farmington Valley,	16.00	41.00	7.00	16.00	48.00	10.50		36.50	1,020.00	3.00	1.00	74.00	9.50	1,282.50
Granby,	4.00	22 00	5.00	3.50	25.00	8 50		18.00	700.00	4.00		18.75	5.00	113 75
Guilford,	3.00	6.00		1.50	13.00	8.00	8.00	18.00		1.00	2.00	18.50	15.00	84.00
Harwinton,	4.20	2.65	2.65	1.50	25.50			17.00		1.50	2 50	15 00	*42.75	115.25
New Milford,	12.00	38.00	19 00	2.50	42.00	34.50	7.00	45.00	400.00			4.50	3.75	608.25
Newtown,	10.75	28.00			56.00	6.00	6.00	48.00	611 00	6.00	5.50	19 50	†36.00	832.75
Simsbury,	11.00	45.75	8.25		55.75			55.00	660.00			16.00		851.75
Stafford Springs,	36.00	176.00	34.00	32.00	43.00	19.00		72.00	1,140.00	22.00		440.19		2,014.19
Suffield,	2.00	13.00	4.00			2.00		17.00	1,200 00	4.50	2.00	30 00		1,274.50
Union (Monroe, etc.),	12.00	15.00	17.25	6.00	99 00	10.00	6 00	75.00	400.00	10.00	21.00	16 00		687.25
Union (Somers, etc.),	11.00	20.00	6.75	1.50	18 00	16.00		26.00		5.00	7.00	47.75	25.70	179.70
Watertown,	29.00	53.00	51.00	23.50	101.00	58.00	11.00	48.00	235.00	36.00	8.00	88.50	42.00	788.00
Willimantic,								79.50	1,775.00					1,854.50
Winsted,	14 10	8.70	11.10	6.30	28.10			13.20	1,105.00	5.70	1.80	12.75		1,201.75
Wolcott,	34.00	72.50	28.25	27 00	47.00	10.00	1.50	25.00		7.00	6 00	15.00	22.00	295.25
Woodstock,	26.40	132.00	73.04	19.36	42 24	81.68		154.88	210.00	16.50	20.24	89.16		765.50
Conn. Horticultural Society														
Conn. J. C. B. A.,	125.00	50.00											‡65 00	240.00
Conn. Dairymen's Association,														

* Draft oxen, $41.00. † Draft oxen. ‡ Bull and four cows.

ANALYSIS OF PREMIUMS AND GRATUITIES.— CONTINUED. FARM PRODUCTS.

SOCIETIES.	Indian Corn.	Wheat.	Rye.	Barley.	Oats.	Beans.	Buckwheat.	Grass Seeds.	Potatoes.	Carrots.	Beets.	Parsnips.	Turnips.	Onions.	Other products.	Total amount for Grain and Root Crops.
New London County,	$2.40		$1.25			$2.00	$0.75		$6.00	$1.25	$0.50	$2.25	$2.75	$3.50	$17.00	$39.65
Windham County,	4.25		1.50	$1.00	$1.50	3.00	1.50		14.00	.75				2.00	7.50	37.00
Tolland County,	5.00		1.50		1.00	2.50	1.00		28.00	1.00	2.00		2.50	3.00	41.25	88.75
Berlin,	5.25	$0.50	.75		.50	1.25			16.25	1.50	3.25	.75	2.00	3.75		35.75
Branford,	5.38					1.13	.25		14.88	.25	1.13	.25	.88	1.00	.74	25.89
Bristol Fair Corp.,	7.00	.75	.75	.75	.50	13.50	.50		22.40	2.00	2.00	1.25	6.25	4.75		62.40
Chester,	9.90		.30			1.85	.30		6.70	.95	1.15		1.70	.95	3.60	27.40
Clinton,	4.50		.25		.25	.90			10.50		.65			.75		17.80
Danbury,	17.75	1.00	2.00	1.00	3.00	2.75	3.75	$0.75	59.00	6.00	9.25	4.00	6.00	7.75	26.25	150.25
Farmington Valley,	2.60	.50	1.00	.75	1.50	1.80	.50		9.50	2.50	7.75	.75	5.00	3.00	9.50	46.65
Granby,	1.00		1.00						1.00							3.00
Guilford,	10.00		.50			8.75	.75		12.25	1.50	1.50	.75	1.00	2.50		39.50
Harwinton,	4.10	1.00	.80	1.00	.80	2.00	1.30		3.25	.75	.75	.50	.75	.75		17.95
New Milford,	2.25		.75	.75		.75			18.25	.50	.75			1.75	5.50	31.25
Newtown,	4.50		1.00		1.00	1.00	1.00		13.00	.50	2.50	.50	1.00	2.00		28.00
Simsbury,																27.40
Stafford Springs,	11.25	1.75	3.00	2.50	2.50	4.50	3.00		45.25	2.25	2.25	1.00	5.25	3.25	8.00	95.75
Suffield,																31.00
Union (Monroe, etc.),	8.00		1.50		1.00	2.50	1.50		17.00		2.00	1.50		5.50	15.00	55.50
Union (Somers, etc.),	1.50	.50	.50			.50	.75		6.75	.75	.75	.50	.75		9.45	22.60
Watertown,	4.25		.75		.75	1.00		2.50	13.75	.75	1.50	.25	.50	1.75	8.00	35.75
Willimantic,		.75	.75		.50	.50	.75		25.00		.50			.25	18.25	17.50
Winsted,	.60		.15						1.95					.83	.15	3.68
Wolcott,	13.75					.50			35.00		1.75		1.50			52.50
Woodstock,	4.18	.88	1.32	.88	1.32	1.76	.44		9.81	1.98	.66		.66	3.96	.66	28.51
Conn. Hort. Society,									.50	1.00	1.00	1.00		4.00	1.50	9.00
Conn. J. B. C. Ass'n,																
Conn. Dairymen's Ass'n,																

ANALYSIS OF PREMIUMS AND GRATUITIES.—Continued. FARM PRODUCTS.

SOCIETIES.	Fruits.	Flowers.	Other Cult. Crops.	Butter.	Cheese.	Honey and Wax.	Bread and Cake.	Sugar, Syrup, Preserved Fruit.	Agricultural Implements.	Mechanical Inventions.	Fine Arts and Fancy Articles.	Decorated Carts and Trains of Oxen.	Plowing at Exhibition.	Grange Exhibit.	Medals.	Diplomas.
New London County,	$8.50			$8.00	$0.50	$0.75	$6.75		$25.00	$42.25	$62.25		$8.00			
Windham County,	66.70	$37.15		4.50	4.50	1.50	15.40	$12.50	5.00		213.75	$62.00				4
Tolland County,	51.50	27.50		5.00			14.50				70.40	25.00				6
Berlin,	36.75	8.00	$18.50	4.50			4.00			14.50	4.75					
Branford,	40.25	2.75	3.22	.38		.75	1.25	8.63			12.38	8.00				
Bristol Park Corp.,	63.50	12.00	61.25	10.00		1.50	16.30	18.80								
Chester,	14.75	2.15	14.50	.90		.60	4.35	8.80		16 80	14.50	12.75				
Clinton,	14.70	4 95	6.10	.45		.30	9.20	3 45	.50	.20	19.85	11.75				
Danbury,	156.75	127.75	7.50	3.50	5.50	43.25	106.00	28.50		779.20	777.35	10.00				75
Farmington Valley,	29.20	2.90	5.81				7.50	5.00			21.50					
Granby,	3.00						1.50									
Guilford,	37.00	1.95	23.50	5.75	.25		10.00	4.40		5.25	11 65	35.00				
Harwinton,	9.50	3.00	8.25	.55	.35		9.50	2.90			10.50	40.00		$8.00		
New Milford,	44.25	5.00		.75	.50	1.00	6.75	4.25			57.75					
Newtown,	27.75	10.25		4.25		3.00	12.75	10.50			113.00				5	15
Simsbury,	34.45															
Stafford Springs,	32.00			3.25		9.35		6.35		24.20	76.85					10
Suffield,	19.75	4.00				1.25		6.50	8.00	5.00	19.60					
Union (Monroe, etc.),	52.25	13.10	11.00	3.00		4.25	9.50	.75			54.00	19.25		15 00		
*Union (Somers, etc.),	10.25						1.80	2.50			18.25	9.00				
Watertown,	27.50	12.25		2.00	1.00	12.75	12.25	4.50	15 50	38.55	8.00					
Willimantic,	18.50			2.00			4 50		5.00	32.00	44.50					7
Winsted,	5.70	.60		.60			1 65	.45			3.44					
Wolcott,	16 00	1.25	8.50	1.50			5.50	2 25			10.50	8 00		15.00		
†Woodstock,	44.00	42.15	24.99	13.20	3.52	1.32	19.54	8.36	.88	7.70	50.67	21.12	37.84			
Conn. Hort. Society,	49.50	404.50	26.50												2	20
Conn. J. C. B. Ass'n,																
Conn. Dairymen's Ass'n,				360.00												

* Historical exhibit, $6.50 ; farm management, $10.00. † Children's exhibit, $17.43.

NUMBER OF ANIMALS EXHIBITED.

SOCIETIES.	Bulls.	Milch Cows.	Heifers.	Calves.	Working Oxen (pairs).	Steers (pairs).	Fat Cattle.	Horses — except speed.	Horses — speed.	Sheep.	Swine.	All other Stock.	Poultry (coops).
New London County,	29	172	19	23	27	3	6	53	42	191	40	..	42
Windham County,	24	64	37	12	..	..	7	28	..	..	..	..	..
Tolland County,	2	22	8	2	19	3	5	28	..	10	3	..	95
Berlin,	4	41	8	11	8	..	..	24	..	19	22	..	76
Branford,	1	4	2	..	14	..	2	8	32	..	..	..	42
Bristol Park Corp.,	14	36	22	5	23	15	1	59	13	23	5	..	157
Chester,	..	2	..	..	7	1	..	10	..	..	3	..	8
Clinton,	2	17	7	7	19	3	4	13	..	47	36	77	..
Danbury,	55	140	68	34	54	88	..	79	82	112	..	..	204
Farmington Valley,	11	42	13	12	24	12	..	23	..	16	8	..	80
Granby,	2	40	..	..	35	10	..	..	..	..	..	..	..
Guilford,	3	6	1	7	49	3	4	17	..	8	4	..	41
Harwinton,	12	4	4	8	30	45	..	23	..	8	8	..	31
New Milford,	10	55	18	8	35	27	10	38	..	..	..	..	16
Newtown,	9	18	11	6	100	5	10	75	..	15	12	..	70
Simsbury,	..	..	..	..	..	..	..	..	..	..	..	..	..
Stafford Springs,	10	73	20	11	14	7	..	26	..	14	..	..	..
Suffield,	..	..	..	..	..	..	..	..	..	..	..	..	..
Union (Monroe, etc.),	3	12	10	4	15	3	2	25	..	3	9	..	9
Union (Somers, etc.),	10	37	19	17	5	12	..	16	..	11	17	..	67
Watertown,	14	44	32	15	80	65	14	31	15	60	25	50	100
Willimantic,	..	..	..	..	..	..	..	..	..	..	..	..	..
Winsted,	..	..	..	..	..	..	..	..	..	..	..	..	..
Wolcott,	14	59	19	18	20	10	2	23	..	10	9	..	44
Woodstock,	..	..	..	..	..	..	..	..	..	..	..	..	..
Connecticut Horticultural Society,	..	..	..	..	..	..	..	..	..	..	..	..	..
Connecticut J. C. B. Association,	..	..	..	..	..	..	..	..	..	..	..	..	..
Connecticut Dairymen's Association,	..	..	..	..	..	..	..	..	..	..	..	..	..

AGRICULTURAL FAIRS IN CONNECTICUT.—1896.

SOCIETIES.	PLACE.	DATE.	ATTENDANCE.					
			Tuesday.	Wednesday.	Thursday.	Friday.	Saturday.	Total.
Connecticut State,	Meriden,	Sept. 9–11,	....	....	....	....	....	....
New London County,	Norwich,	Sept. 22–25,	200	4,000	2,000	1,500	....	7,700
Windham County,	Brooklyn,	Sept. 23–24,	....	2,500	2,000	....	....	4,500
Tolland County,	Rockville,	Sept. 15–17,	1,000	4,000	5,000	....	....	10,000
Berlin,	Berlin,	Sept. 23,	....	1,200	....	....	....	1,200
Branford,	Branford,	Sept. 22–26,	....	....	....	....	....	3,500
Bristol Park Corp.,	Bristol,	Sept. 30, Oct. 1,	....	1,800	2,500	....	....	4,300
Chester,	Chester,	Oct. 7–8,	....	200	800	....	....	1,000
Clinton,	Clinton,	Sept. 28,	....	....	....	....	....	2,500
Danbury,*	Danbury,	Oct. 5–10,	4,193	5,580	17,251	16,067	5,520	50,855
Farmington Valley,	Collinsville,	Sept. 9–10,	....	1,000	3,300	....	....	3,400
Granby,	Granby,	Sept. 3–4,	800	1,500	....	....	....	2,300
Guilford,	Guilford,	Sept. 30,	....	....	....	....	....	3,000
Harwinton,	Harwinton,	Oct. 6,	7,500	....	....	....	....	7,500
New Milford,	New Milford,	Sept. 8–10,	500	3,600	900	....	....	5,000
Newtown,	Newtown,	Sept. 29, Oct. 1,	1,000	3,000	3,500	....	....	7,500
Simsbury,	Simsbury,	Sept. 30, Oct. 1,	....	....	....	....	....	....
Stafford Springs,	Stafford Springs,	Oct. 7–8–9,	....	2,000	6,000	2,000	....	10,000
Suffield,	Suffield,	Sept. 22–24,	....	....	....	....	....	....
Union (Monroe, etc.),	Huntington,	Sept. 23–25,	....	479	1,972	1,722	....	4,173
Union (Somers, etc.),	Somers,	Oct. 1,	....	....	....	....	....	5,000
Watertown,	Watertown,	Sept. 23–25,	....	1,200	2,800	....	....	4,000
Willimantic,	Willimantic,	Oct. —,	1,500	5,500	3,000	....	....	6,000
Winsted,	Winsted,	Sept. 15–16,	440	1,280	....	....	...	1,720
Wolcott,	Wolcott,	Oct. 15,	....	....	1,000	....	....	1,000
Woodstock,	South Woodstock,	Sept. 14–15,	2,736	2,484	....	....	....	5,220
Horticultural Society,†	Hartford,		....	....	....	....	....	2,000
Conn. Dairymen's Association,	Hartford,	Jan. 21–23,	....	....	....	....	....	....

* Monday, 2,244. † March 31; April 1–2; June 10–11; July 22; Sept. 23–24; Nov. 9–11.

OFFICIAL LIST OF FARMERS' CLUBS IN CONNECTICUT, 1896–97.

NAME OF CLUB.	PRESIDENT.	SECRETARY.
New Haven County ...	Prof. Wm. H. Brewer.	Cullen B. Foote.
Cheshire..............	Alfred S. Bennett... ..	Fred Doolittle.
East Windsor.........	Lemuel Stoughton, Jr..	John F. Fitts.
Green's Farms.........	J. H. Jennings........	Edward C. Birge.
Greenwich	S. R. Close............	G. A. Lockwood.
Naugatuck	J. B. Tolles...........	L. W. Kane.
Newington......	H. A. Whittlesey......	J. S. Kirkham.
New Britain.........	L. S. Wells............	A. C. Blake.
Wilton	D. N. Van Hoosear....	J. C. Dudley.

CONNECTICUT DAIRYMEN'S ASSOCIATION.

ADRIAN R. WADSWORTH, *Pres't*, Farmington.
F. H. STADTMUELLER, *Sec'y*, Elmwood.
W. I. BARTHOLOMEW, *Treas.*, Putnam.

CONNECTICUT POMOLOGICAL SOCIETY.

J. H. HALE, *Pres't*, S. Glastonbury. G. S. BUTLER, *Sec'y*, Cromwell.

CONNECTICUT HORTICULTURAL SOCIETY.

EDWARD BROWNE, *Pres't*. T. J. MCRONALD, *Sec'y*.
JOHN E. BRUCE, *Treas.*

CONNECTICUT JERSEY CATTLE BREEDERS' ASSOCIATION.

S. C. COLT, *Pres't*, Elmwood. R. A. POTTER, *Sec'y*, Bristol.
B. W. COLLINS, *Treas.*, Meriden.

CONNECTICUT CREAMERY ASSOCIATION.

J. E. LEONARD, *Pres't*, Jewett City.
FRANK AVERY, *Sec'y* and *Treas.*, Wapping.

CONNECTICUT SHEEP BREEDERS' ASSOCIATION.

R. S. HINMAN, *Pres't*, Oxford. JOHN H. WADHAMS, *Sec'y*, Goshen.

CONNECTICUT FORESTRY ASSOCIATION.

REV. HORACE WINSLOW, *Pres't*, Weatogue.
MISS MARY WINSLOW, *Sec'y and Treas.*, Weatogue.

CONNECTICUT STATE POULTRY SOCIETY.

GEORGE B. FISHER, *Pres't*, Hartford. R. G. BAILEY, *Sec'y*, Hartford.

WESTERN CONNECTICUT POULTRY ASSOCIATION.

E. B. PARSONS, *Pres't*, West Winsted. H. J. PIERRE, *Sec'y*, Winsted.

MERIDEN POULTRY ASSOCIATION.

L. E. COE, *Pres't*. JOSHUA SHUTE, *Sec'y*.

NEW HAVEN POULTRY ASSOCIATION.

W. P. ENSIGN, *Pres't*. EDWARD A. TODD, *Sec'y*.

OFFICIAL DIRECTORY

OF THE

CONNECTICUT PATRONS OF HUSBANDRY,

FOR 1897.

OFFICERS OF THE STATE GRANGE.

Master, Stephen O. Bowen, Eastford.
Overseer, G. C. Beckwith, Nepaug.
Lecturer, Mrs. E. H. Barnes, Southington.
Steward, Joel H. Brewer, Hillstown.
Assistant Steward, H. C. C. Miles, Milford.
Chaplain, Rev. D. B. Hubbard, Little River.
Treasurer, Norman S. Platt, Cheshire.
Secretary, Henry E. Loomis, Glastonbury.
Gate Keeper, Henry W. Morse, Jewett City.
Ceres, Mrs. M. C. Gaylord, Bristol.
Pomona, Mrs. Mary J. Brooks, Clinton.
Flora, Mrs. J. M. Robinson, Webster, Mass.
Lady Stew., Mrs. F. B. Crandall, Farmington.

Executive Committee.

B. C. Patterson, Torrington,	Term	expires,	1898.
Orson S. Woods, Ellington,	"	"	1899.
J. H. Hale, South Glastonbury,	"	"	1900.
S. O. Bowen, *ex officio*, Eastford,	"	"	1898.
Henry E. Loomis, *ex officio*,	"	"	1898.

Finance Committee.

Levi S. Wells, New Britain. Timothy Sedgwick, West Hartford.
Henry T. Dayton, Watertown.

Deputies.

General Deputy, James H. Blakeman, Oronoque.

Hartford County, C. E. Adams, Wethersfield.
New Haven County, Geo. H. Bartlett, North Guilford.
Middlesex County, Samuel A. Chalker, Saybrook.
New London County, E. J. Hempstead, New London.
Windham County, Lewis J. Wells, South Woodstock.
Tolland County, J. M. Larned, Stafford Springs.
Fairfield County, Simon C. Bradley, Greenfield Hill.
Litchfield County, L. W. Whittlesey, Morris.

OFFICERS OF THE GRANGES.

NAME.		MASTER.	LECTURER.	SECRETARY.
POMONA GRANGES.				
Central Pomona,	No. 1,	John H. Francis, Meriden,	Mrs. John S. Kirkham, Newington,	Charles E. Bacon, Middletown.
Quinebaug Pomona,	2,	Walter F. Day, Danielson,	Miss L. E. Spalding, Brooklyn,	Mrs. N. C. Cleveland, Hampton.
East Central Pomona,	3,	Wm. B. Sprague, Andover,	Mrs. Fannie L. Tilden, Ellington,	Mrs. Laura J. Brewer, Hillstown.
Mountain County Pomona,	4,	J. Q. Ames, Litchfield,	L. G. Humphreville, Northfield,	N. S. Stevens, East Canaan.
New Haven Co. Pomona,	5,	Geo. A. Hopson, East Wallingford,	Rev. F. Countryman, N. Branford,	Mrs. L. P. Tuttle, North Haven.
New London Co. Pomona,	6,	J. B. Bliven, Baltic,	J. E. Hall, Colchester,	H. W. Morse, Jewett City.
Excelsior Pomona,	7,	Michael F. Skelley, Woodbury,	F. S. Truesdell, Naugatuck,	F. M. Candee, Naugatuck.
Seaview Pomona,	8,	Eugene D. Smith, Madison,	George B. Hall, Moodus,	Cyrus D. Evarts, Killingworth.
Fairfield Co. Pomona,	9,	Simeon Pease, Greenfield Hill,	Rev. J. Howard Hoyt, New Canaan,	C. D. H. Kellogg, Brookfield.
SUBORDINATE GRANGES.*				
Granby,	No. 5,	Frederick J. Jewett, North Granby,	Mrs. Ellen S. White, North Granby,	Lydia C. Loveland, North Granby.
Washington,	11,	S. J. Nettleton, Wash. Dep't,	Mrs. E. C. Whitehead, Wash. Dep't,	Mrs. Sarah R. Ford, Wash. Dep't.
East Granby,	12,	C. H. Hanchett,	Mrs. Annie Dibble,	Mrs. Mary E. Lobdell.
Tunxis,	13,	Geo. F. Woodford, Bloomfield,	F. L. Granger, Jr., Bloomfield,	Alfred C. Case, Bloomfield.
Hope,	20,	H. J. Newberry, Torrington,	Mrs. Jennie Wilson, Torrington,	K. K. Kimberly, West Torrington.
Lebanon,	21,	James B. Bliven, Baltic,	Mrs. M. S. W. Throop,	Nathaniel S. Loomis.
Advance,	22,	Charles Eddy, Simsbury,	Miss Nannie Phelps, Simsbury,	Mrs. J. W. Holcomb, Weatogue.
Cheshire,	23,	Henry T. Hubbell, Cheshire,	Mrs. A. M. Rice, Cheshire,	C. T. Hotchkiss, West Cheshire.
Berlin,	24,	Daniel Webster, Beckley,	F. H. Shaw, Berlin,	James A. Beale, Berlin.
Union,	25,	Wallace O. Camp, Plantsville,	Mrs. M. H. Moore, Southington,	Mrs. Estella H. Barnes, Southington.
Glastonbury,	26,	H. E. Loomis,	George H. Carrier,	E. P. Miller, South Glastonbury.
Suffield,	27,	H. D. Tinker,	Miss Ella M. Clark,	Arthur Sikes.
Meriden,	29,	John H. Francis, Meriden,	Julius H. Yale, Meriden,	William T. Owen, Meriden.
Wapping,	30,	W. C. Thompson, Manchester,	Mrs. Sarah J. Collins, Wapping,	Walter N. Foster.
Manchester,	31,	A. W. Hollister, South Manchester,	Mrs Mary A. Strong, S. Manchester,	Mrs. Mary R. Chamberlain, S.M'nch'r.
North Cornwall,	32,	Wm. R. Brush, West Cornwall,	Miss Adele T. Peck, West Cornwall,	Mrs. Niles Scoville, West Cornwall.
Wallingford,	33,	G. A. Hopson, East Wallingford,	Mrs. C. A. D. Allen, E. Wallingford,	D. W. Ives, East Wallingford.
Cawasa,	34,	F. A. Bidwell, Canton Center,	Mrs. Z. J. Hinman, Collinsville,	F. G. Humphrey, Canton Center.
North Haven,	35,	Robert O. Eaton, Montowese,	Mrs. Emma Tuttle, New Haven,	Charles H. Thorpe, New Haven.
Little River,	36,	W. W. Jewett, Rawson,	Mrs. M. W. Jewett, Hampton,	E. C. Jewett, Clark's Corner.
East Hartford,	37,	G. H. Putnam, Box 177 E. Hartford,	John Dimon, East Hartford,	Frank Roberts, Silver Lane.
New Canaan,	38,	L. H. Mead,	Rev. J. Howard Hoyt,	W. F. Waterbury, North Stanford.
Burritt,	39,	Arthur C. Blake, New Britain,	Robert W. Andrews, New Britain,	Mrs. Charles M. Fanning, N. Britain.
Senexet,	40,	Geo. Austin Bowen, Woodstock,	Mrs. Anna L. Gordon, N. Woodstock,	Leonard H. Healy, North Woodstock.
Konomoc,	41,	A. J. Hempstead, New London,	Miss M. B. Deming, New London,	E. J. Hempstead, New London.
Mattabessett,	42,	J. H. Atkins, Middletown,	Mrs. Rose Gilbert, Middletown,	H. O. Daniels, Middletown.
Brooklyn,	43,	N. G. Williams,	J. B. Stetson,	H. D. Crosby.
Newington,	44,	C. L. Luce, New Britain,	Miss Lizzie A. Root, Newington,	Herbert C. Francis, Newington.

* Post-office same as name of Grange unless otherwise indicated.

Harwinton,	**45,**	J. M. Baldwin, Jr.,	Mrs. Julia Woodin,	**Mrs. Julia A. Barber.**
Ellington,	**46,**	Orson West,	Mary J. Kimball,	**Alberton C. Kibbe.**
Bolton,	**47,**	George Curtiss, Andover,	Miss A. E. Sperry, Bolton,	Miss A. N. Loomis, Bolton.
Whigville,	**48,**	E. F. Gaylord, Bristol,	Miss Etta A. Moses, Unionville,	George W. Hart, Unionville.
Farmington,	**49,**	C. S. Pyatt, Unionville,	Paul Wollinberg, Farmington,	Gustavus Cowles, Farmington.
Westfield,	**50,**	J. C. Atkins, Meriden, Wes'ld b.,	Mrs. A. L. Congdon, Middletown,	M. W. Wilcox, East Berlin.
Tolland,	**51,**	F. A. West, Rockville,	Mrs. L. H. Reed, Rockville,	Charles S. Hurlbut, Rockville.
Vernon,	**52,**	A. W. Post, Vernon Center,	Mrs. C. W. Pitkin, Talcottville,	Miss J. H. Lathrop, Vernon Center.
Poquonock,	**53,**	Eli S. Hough,	Mrs. Mary E. Ladd,	Mrs. Alice J. Alford.
Plainville,	**54,**	C. M. Woodford, Plainville,	Mrs. Louie Ryder, Plainville,	Mrs. E. M. Baker, Plainville.
Stafford,	**55,**	F. A. Lasbury, Stafford,	Mrs. D. J. Witt, Stafford,	Mrs. H. F. Cady, Stafford.
East Haddam,	**56,**	George B. Hall, Moodus,	Lillian B. Russell, Moodus,	S. E. Williams, Moodus.
Durham,	**57,**	C. W. Coe, Durham Center,	Mrs. Alice Hull, Durham Center,	F. P. Brainerd, Durham Center.
West Hartford,	**58,**	Frank H. Strong, West Hartford,	Mrs. M. A. Sedgwick, West Hartf'd,	Timothy Sedgwick, West Hartford.
Old Saybrook,	**59,**	William Y. Ayer, Old Saybrook,	Miss Angeline I. Ingham, Old Sayb'k,	Miss Olive N. Clark, Old Saybrook.
Crystal Lake,	**60,**	O. E. Bowen, Eastford,	Lillian E. Hiscox, Woodstock V.,	Arthur M. Keith, Eastford.
Wolf Den,	**61,**	Wm. G. Jennings, Pomfret,	George L. Ingalls, Abington,	Mrs. E. S. Estabrooks, Abington.
Eureka,	**62,**	C. F. Loomis, Bakersville,	R. M. Olmsted, Nepaug,	G. F. Douglass, Collinsville.
Middlefield,	**63,**	Alfred H. Augur, Middlefield,	Mrs. Ida E. Augur, Middlefield,	Miss Clara E. Smith, Middlefield.
Mansfield,	**64,**	David H. Snow, Storrs,	Miss Harriet L. Smith, Storrs,	A. C. Gilbert, Storrs.
Quinnatisset,	**65,**	Wilfred C. Mills, Wilsonville,	Miss Edith Woodward, Wilsonville,	B. H. Evans, Thompson.
Killingworth,	**66,**	L. D. Parmelee, Killingworth,	D. K. Stevens, Killingworth,	Miss Minnie F. Stevens, Killingworth.
Cromwell,	**67,**	Cabel S. Pease,	Miss Sadie E. Noble,	Miss Hattie M. Hubbard.
Natchaug,	**68,**	Laura R. Hough, Chaplin,	George C. Kingsbury, Chaplin,	Mrs. Julia G. Russ, Chaplin.
Shetucket,	**69,**	Gerald Waldo, Scotland,	Miss Leora E. Pendleton, Scotland,	Miss Mary A. Smith, Scotland.
Canterbury,	**70,**	Charles Barstow, Canterbury,	John O. Smith, South Canterbury,	Levi N. Clark, South Canterbury.
Mad River,	**71,**	A. H. Coe, Waterbury,	Mrs. Elsie Hitchcock, Waterbury,	Mrs. Annie E. Pierpont, Waterbury.
Plymouth,	**72,**	Cyrus A. Skilton, Plymouth,	Carrie B. Ploucquet, Plymouth,	Ard Welton, Plymouth.
Indian River,	**73,**	Dennis Fenn, Milford,	Mrs. Elliott D. Clark, Milford,	Fred M. Smith, Milford.
Winchester,	**74,**	George Beach, Winchester Center,	Mrs. H. B. Humphrey, Win. Center,	Willis L. Wetmore, Winchester Cen'r.
Coventry,	**75,**	H. B. Pomeroy, Coventry,	Miss Fannie J. Kingsbury, Coventry,	Charles Robertson, Rockville.
Andover,	**76,**	William B. Sprague, Andover,	Mrs. A. M. Snow, Andover,	Winthrop White, Andover.
Clinton,	**77,**	Wilbur J. Brooks, Clinton,	Mrs. Mary J. Brooks, Clinton,	C. H. Evarts, Clinton.
Colchester,	**78,**	Joseph E. Hall, Colchester.	James R. Dutton, Colchester,	Mrs. Hattie J. Strong, Colchester.
Housatonic,	**79,**	A. C. Innis, Stratford,	William E. Smith, Stratford,	Mrs. Georgie E. Smith, Stratford.
Guilford,	**81,**	George W. Dudley, Guilford,	William A. Dudley, Guilford,	Walter S. Watrous, Guilford.
Colebrook,	**82,**	A. E. Pasco, West Winsted,	Miss L. J. Vining, Millbrook,	Mrs. E. C. Turner, Colebrook.
Totoket,	**83,**	F. Countryman, North Branford,	Mrs. Frank Foote, North Branford,	Mrs. G. C. Linsley, North Branford.
Foxon,	**84,**	Andrew J. Granniss,	Frank M. Sperry,	Miss Mary E. Grannis.
Wangumbaug,	**85,**	L. B. Hicks, South Coventry,	Mrs. Etta L. Loomis, So. Coventry,	H. F. Parker, South Coventry.
Webutuck,	**86,**	F. D. Rundall, Amenia, N. Y.,	Miss A. L. Reynolds, So. Amenia, N. Y.,	Miss Eva Scott, Amenia Un., N. Y.
Hillstown,	**87,**	George E. Samson, Addison,	Mrs. Laura J Brewer, Hillstown,	Mrs. Mary M. Hills.
Still River,	**88,**	Sherman E. Bunnell, Winsted,	Mrs. Sarah Bull, Winsted,	George L. Foskett, Winsted.
Ekonk,	**89,**	C. L. Gardiner, Ekonk,	A. H. Stanton, Ekonk,	J. E. Tanner, Campbell's Mills.
Ashford,	**90,**	Burt H. Gardner, Warrenville,	Miss Lena M. Gallup, Ashford,	Wilbur Lamphear, Ashford.

OFFICERS OF THE GRANGES—Continued.

Name.		Master.	Lecturer.	Secretary.
Subordinate Granges.—*Con't.*				
Seymour,	91,	Frank H. Downs,	Mrs. H. Moshier, Box 876, Ansonia,	Mrs. L. Esther Downs.
Harmony,	92,	H. H. Wheeler, Monroe,	Miss Rose Sinclair, Monroe,	E. C. Shelton, Stepney Depot.
Border,	93,	Frank P. Fenton, Willimantic,	Geo. H. Andrews, Box 56, Willimantic,	Miss L. M. Huntington, Mans'f'd Cen.
East Windsor,	94,	Geo. S. Phelps, Warehouse Point,	William F. English, East Windsor,	Miss Nettie T. Bissell, Windsor.
Jewett City,	96,	H. W. Morse,	H. M. Miner,	C. C. Palmer.
Putnam,	97,	C. E. Pierce, Putnam,	Miss Alice B. Cutler, Putnam,	Edwin L. Wood, Putnam.
Barkhamsted,	98,	F. H. Jones, East Hartland,	Miss Lucia A. Merrell,	George A. Weed, North Canton.
Hamden,	99,	Ira W. Beers, Hamden,	Miss Lillian E. Terrill, Hamden,	Mrs. Fannie Collett, Hamden.
Taghhannuck,	100,	E. H. Chapman, Wassaic, N. Y.,	Charles C. Dean, Ellsworth,	Miss Lottie A. St. John, Ellsworth.
Mashapaug Lake,	101,	L. M. Reed, Union,	Mrs. Emily Young, Union,	Mrs. Georgie E. Reed, Stff. Springs.
Beacon Valley,	103,	John R. Platt, Prospect,	Mrs. Josephine Downs, Westville,	Frank S. Truesdell, Naugatuck.
North Guilford,	104,	Geo. H. Bartlett, North Guilford,	Rev. Milton R. Kerr, North Guilford,	Edgar W. Lane, North Guilford.
Somers,	105,	Lester W. Russel, Somers Point,	E. D. Avery, Somers Point,	C. J. Stephenson, Somers Point.
East Haven,	106,	W. F. Andrews, East Haven,	Mrs. Ewell Lewis, East Haven,	Florence R. Andrews, East Haven.
Litchfield,	107,	William B. Morse,	Milo D. Beach,	Fred L. Sharp.
Woodbridge,	108,	Arthur H. Doolittle, Westville,	Charles P. Auger, Westville,	Henry E. Baldwin, Westville.
East Hampton,	109,	M. S. Purple, East Hampton,	Mrs. Lizzie A. Hall, East Hampton,	Miss Katie Jones, East Hampton.
Preston City,	110,	H. H. Palmer, Preston,	E. P. Barnes, Norwich,	Miss Fannie F. Fitch, Preston.
Killingly,	112,	Marcus Bastow, East Killingly,	Mrs. Alice E. Wilbur, Danielson,	Walter F. Day, Danielson.
Highland,	113,	A. A. Tillinghast, South Killingly,	Emily P. Tubbs, South Killingly,	Mrs. F. A. Sanderson, So. Killingly.
Wethersfield,	114,	R. R. Wolcott, Wethersfield,	Lizzie Willard, Wethersfield,	Dudley Wells, 2d, Wethersfield.
Rocky Hill,	115,	William Warner,	Mrs. Jane E. Blinn,	L. B. Williams.
Bristol,	116,	Elbert Manchester, Bristol,	Milo L. Norton, Bristol,	E. W. Gaylord, Bristol.
Unity,	117,	Clarence E. Lamb, Deep River,	Miss Alice A. Kirtland, Chester,	Frederic C. Pratt, Deep River.
Beacon,	118,	Henry B. Peck, Northfield,	Mrs. Mary E. French, Northfield,	C. A. French, Northfield.
Morris,	119,	Frederick Stockman, East Morris,	Miss Elizabeth Whittlesey, Morris,	Silas E. Stockman, East Morris.
Madison,	120,	N. D. Meigs, Madison,	Mrs. L. E. Whedon,	Charles F. Hill.
Bethlehem,	121,	Wallace P. Hayes, Bethlehem,	Mrs. Mariette Griswold, Bethlehem,	Mrs. E. K. Hayes, Bethlehem.
Watertown,	122,	A. H. Mattoon, Oakville,	Mrs. Celia S. Peck, Watertown,	J. G. Skilton, Watertown.
Westbrook,	123,	S. A. Chalker, Saybrook,	H. E. Kelsey,	———— ————,
Higganum,	124,	Clifton W. Kelsey,	Myron G. Skinner,	Robert H. Freeman.
Hollenbeck,	125,	D. H. Dean, Huntsville,	Mrs. R. P. Pendleton, South Canaan,	Mrs. J. C. Hakes, Huntsville.
Pleasant Valley,	126,	D. L. Somers, North Woodbury,	M. F. Skelley, North Woodbury,	W. T. Benjamin, Hotchkissville.
Good Will,	127,	Harold B. Waldo, Naubuc,	Miss Cora A. Hale, Glastonbury,	Mrs. Alice C. Barrows, Glastonbury.
Orange,	128,	Watson S. Woodruff, Orange,	Mrs. E. B. Russell,	C. V. Woodruff, Derby, Box 426.
Pohtatuck,	129,	E. F. Northrop, Newtown,	Otis O. Wright, Sandy Hook,	Leonard A. Botsford, Newtown.
Farmill River,	130,	G. M. Wakelee, Shelton,	Miss Ruth O. Sturges, Shelton,	Mrs. W. C. Hubbell, Shelton.

Columbia,	131,	F. A. Hunt, Columbia,	Miss Mary L. Hunt, Columbia.	Miss Amelia J. Fuller, Columbia.
Wichita,	132,	Austin R. Humphrey, Warren,	Mrs. Belle G. Johnson, Warren,	Max Schnell, Warren.
Greenfield Hill,	133,	John C. Lobdell, Greenfield Hill,	G. H. Merwin, Greenfield Hill,	C. H. Bradley, Greenfield Hill.
Trumbull,	134,	J. M. Tucker, Trumbull,	C. A. Wheeler, Trumbull,	Miss Jennie A. Wheeler, Trumbull.
Silver Lake,	135,	Louis Schwab, Sharon,	Miss Mary Merwin, Sharon,	Rev. E. D. Kelsey, Sharon.
East Canaan,	136,	N. S. Stevens, East Canaan,	Miss Minnie E. Briggs, East Canaan,	Charles H. Johnson, East Canaan.
Willington,	137,	Charles T. Preston, Willington,	Charles H. Brown, Willington,	George A. Cosgrove, Willington.
North Stonington,	138,	John B. Perry, Clarks Falls,	Mrs. E. H. Wheeler, No. Stonington,	John L. York, North Stonington.
Middlebury,	139,	E. A. Fenill, Middlebury,	Martha E. Judd, Middlebury,	Esther M. Woodford.
Plainfield,	140,	J. P. Lathrop, Central Village,	A. H. Mathewson, Plainfield,	David C. Kinne, Plainfield.
Brookfield,	141,	Henry L. Foote, Brookfield Center,	Rev. C. W. Francis, Brookfield C'ter,	C. D. H. Kellogg, Brookfield Center.
Rock Rimmon,	142,	John L. Rice, Beacon Falls,	Mrs. Maria Bronson, Beacon Falls,	Mrs. Mary R. Clark, Beacon Falls.
Goshen,	143,	Geo. S. Hammond, West Goshen,	Miss Grace A. Hammond, W. Goshen,	Harrison H. Ives, West Goshen.
Prospect,	144,	Mr. S. A. Talmadge, Prospect,	Mrs. Mary W. Phipps, Prospect,	Sara A. Talmadge.
Rippowam,	145,	James Bedell, Long Ridge,	Mrs. L. B. Martin, High Ridge,	Mrs. S. G. Hoyt, North Stamford.
Norfield,	146,	Horace C. Hurlbut, Weston,	Mrs. Julia E. Lane, Westport,	Vanderbilt Godfrey, Norwalk.
Lyme,	147,	J. Ely Beebe, North Lyme,	Mrs. F. S. Fosdick, North Lyme,	Lodowick Bill, Hamburgh.
Westport,	148,	Eibert N. Sipperley, Westport,	Mrs. A. N. Sipperley, Westport,	William J. Wood, Westport.
———,	149,	George B. Beers, Plattsville,	———	William M. Gallup, Easton.

TREASURER'S REPORT.

F. M. Bartholomew, Treasurer, *in account with*

State Board of Agriculture.

Dr.

Feb. 21, 1896, Received from Geo. T. Sanger, Treas., . . .	$765.01
Jan. 6, 1897, State appropriation, ...	3,500.00
	$4,265.01

Cr.

1896.		
Jan. 24.	A. M. Bancroft, expenses, Lebanon, .	$8.25
"	E. S. Vail, lecture, New Haven, . .	29.25
"	Dwight Loomis, legal advice, . .	15.00
"	C. S. Phelps, expenses, Lebanon, . .	4.50
"	W. C. Sturgis, lecture, New Haven, .	45.80
March 3.	Geo. T. Sanger, ...	1.08
"	Ætna Stamp Works, seal, ...	4.50
"	Hartford Engraving Co., ...	55.00
April 9.	E. H. Jenkins, ...	23.49
"	H. W. Collingwood, ...	6.60
"	Charles D. Woods, ...	9.85
"	C. S. Phelps, ...	13.98
May 9.	A. G. Gulley, ...	1.51
Nov. 11.	A. G. Gulley, ...	47.56
1897.		
Jan. 7.	J. M. Hubbard, ...	27.50
"	John Depew, ...	27.45
"	The Case, Lockwood & Brainard Co., .	167.60
"	C. S. Phelps, ...	29.72
"	Hartford Evening Post, ...	24.75
"	J. H. Hale, ...	27.84
"	G. S. Butler, ...	89.80
"	W. E. Simonds, ...	25.00
"	Nash & Peffers, ...	5.00
"	Burr Brothers, ...	24.75
"	Turner House, ...	248.00
"	W. C. Sturgis, ...	4.98
"	J. E. Gardner, ...	64.15

Jan. 7.	W. E. Britton,		$41.11	
"	A. B. Peebles,		27.47	
"	R. S. Hinman,		10.00	
"	Miss E. Talcott,		28.16	
"	A. F. Hunter,		33.38	
"	C. D. Woods,		56.27	
"	N. S. Platt,		5.28	
"	L. J. Wells,		11.02	
"	W. B. Sprague,		6.59	
"	John Thompson,		29.25	
"	Clifton Peck,		22.22	
"	A. B. Pierpont,		32.80	
"	J. F. Brown,		44.42	
"	W. H. Hammond,		43.58	
"	Dudley Wells,		12.50	
"	N. H. Sherwood,		16.66	
"	Theron E. Platt,		6.55	
"	Geo. L. Foskett,		13.22	
"	S. A. Chalker,		36.34	
"	F. M. Bartholomew,		63.80	
"	T. S. Gold, salary,	$1,000.00		
	traveling expenses,	190.86		
	postage,	56.60		
	express and freight,	22.59		
	telegraph,	1.00		
	expenses at Danbury,	33.50		
	Standard,	2.00		
	A. R. Yale,	2.80		
	Veterinary Journal,	3.00		
	stationery and sundries,	5.35—	1,317.70	
Jan. 7.	W. C. Graham,		190.00	
"	Balance on hand,		1,338.83 —	$4,265.01

We, the undersigned, having carefully examined the above accounts and compared the vouchers with the same, do find them correct.

JOHN THOMPSON,
SAM'L A. CHALKER,
NELLIS H. SHERWOOD, } *Auditors.*

HARTFORD, CONN., Jan. 7, 1897.

STATE OF CONNECTICUT

TWENTIETH ANNUAL REPORT

OF

The Connecticut Agricultural Experiment Station

For 1896

Printed by Order of the General Assembly

The publications of this Station are sent free to every citizen of Connecticut who applies for them. Address, The Conn. Agricultural Experiment Station, New Haven, Conn.

NEW HAVEN:
THE TUTTLE, MOREHOUSE & TAYLOR PRESS
1897

CORRECTIONS.

In the Sixteenth Report of this Station, for 1892, p. 155, is given a statement of the quantities of nitrogen and ash ingredients "in one ton of onions." This should read "in one-half ton of onions," or else the figures contained in the statement should be doubled.

In the Nineteenth Report of this Station, for 1895, p. 228, is given an analysis of Atlas Gluten Meal. This article is made by the Atlas Distilling Co., of Peoria, and not by the Chicago Sugar Refinery.

The guaranteed per cent. of available phosphoric acid in Chittenden's Potato Phosphate, No. 6477, is 6.0 per cent.; not 8.0 per cent. as stated on page 145 of the present Report.

CONNECTICUT AGRICULTURAL EXPERIMENT STATION.

OFFICERS AND STAFF FOR 1896.

STATE BOARD OF CONTROL.

Ex-officio.

HIS EXCELLENCY O. VINCENT COFFIN, *President*.

	Term expires,
Appointed by Connecticut State Agricultural Society:	
HON. E. H. HYDE,* Stafford, *Vice-President*.	July 1, 1897
Appointed by Board of Trustees of Wesleyan University:	
PROF. W. O. ATWATER, Middletown.	1897
Appointed by Governor and Senate:	
EDWIN HOYT, New Canaan.	1898
JAMES H. WEBB, Hamden.	1899
Appointed by Board of Agriculture:	
T. S. GOLD, West Cornwall.	1898
Appointed by Governing Board of Sheffield Scientific School:	
W. H. BREWER, New Haven, *Secretary and Treasurer*.	1899
Ex-officio.	
S. W. JOHNSON, New Haven, *Director*.	

Executive Committee.

STATION STAFF.

Chemists.

S. W. JOHNSON, *Director*.
E. H. JENKINS, PH.D., *Vice-Dir*.
A. L. WINTON, PH.B.
T. B. OSBORNE, PH.D.
A. W. OGDEN, PH.B.
G. F. CAMPBELL, PH.B.
W. L. MITCHELL, PH.B.

Mycologist.

WILLIAM C. STURGIS, PH.D.

Horticulturist.

W. E. BRITTON, B.S.

Grass Gardener.

JAMES B. OLCOTT, South Manchester.

Stenographer and Clerk.

MISS C. S. GREEN.

In charge of Buildings and Grounds.

CHARLES J. RICE.

Laboratory Helpers.

HUGO LANGE. JULIUS KORN.

Sampling Agent.

C. L. BACKUS, Andover.

*Deceased. Succeeded by S. M. Wells, Wethersfield.

Notice as to Bulletins.

The Bulletins of this Station are mailed free to citizens of Connecticut who apply for them, and to others as far as the limited editions permit.

Applications should be renewed annually before January 1st.

The matter of all the Bulletins of this Station, in so far as it is new or of permanent value, will be made part of the Annual Report of the Station Staff.

All Bulletins earlier than No. 71 and Nos. 83, 93, 101, 102 and 118 are exhausted and cannot be supplied.

Notice as to Supply of Station Reports.

The Station has no supply of its Annual Reports for the years 1877, 1878, 1879, 1880, 1881, 1882, 1883, 1887 and 1891.

The Annual Report of this Station, printed at State expense, is by law limited to an edition of 12,000 copies, of which 5,000 copies are bound with the annual Report of the Connecticut State Board of Agriculture, and distributed by the Secretary of the Board, T. S. Gold, West Cornwall, Conn.

After exchanging with other Experiment Stations and Agricultural Journals, the Reports remaining at the disposal of the Station will be sent to citizens of Connecticut who shall seasonably apply for them, and to others as long as the supply lasts.

ANNOUNCEMENT.

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION was established in accordance with an Act of the General Assembly approved March 21, 1877, "for the purpose of promoting Agriculture by scientific investigation and experiment."

The Station is prepared to analyze and test fertilizers, cattle-food, seeds, milk, and other agricultural materials and products, to identify grasses, weeds, moulds, blights, mildews, useful or injurious insects, etc., and to give information on various subjects of Agricultural Science, for the use and advantage of the citizens of Connecticut.

The Station does not undertake sanitary analyses of water.

The Station makes analyses of Fertilizers, Seed-Tests, etc., for the citizens of Connecticut, without charge, provided—

1. That the results are of use to the public and are free to publish.
2. That the samples are taken from stock now in the market, and in accordance with the Station "Instructions for Sampling."
3. That the samples are fully described and retail prices given on the Station "Forms for Description."

The officers of the Station will take pains to obtain for analysis samples of all the commercial fertilizers sold in Connecticut; but the organized coöperation of farmers is essential for the full and timely protection of their interests. Granges, Farmers' Clubs, and like associations can efficiently work with the Station for this purpose, by sending in duly authenticated samples early during each season of trade.

☞ By a recent Act of Legislature it is made the business of this Station to examine articles of food and drink on sale in Connecticut, with reference to their adulterations.

Here it may be stated that, *until further notice,* the Station will examine only such samples of food and drink as are collected by its agents or such as shall be taken under its advice, and by the methods it shall prescribe or approve.

All other work proper to the Experiment Station that can be used for the public benefit will be done without charge. Work for the private use of individuals is charged for at moderate rates. The Station undertakes no work the results of which are not at its disposal to use or publish, if deemed advisable for the public good.

Results of analysis or investigation that are of immediate general interest are published in Bulletins, copies of which are sent to each Post Office in the State, and to every citizen of the State who applies for them. The results of all the work of the Station are summed up in the Annual Reports made to the Governor.

It is the wish of the Board of Control to make the Station as widely useful as its resources will admit. Every Connecticut citizen who is concerned in agriculture, whether farmer, manufacturer, or dealer, has the right to apply to the Station for any assistance that comes within its province to render, and the Station will respond to all applications as far as lies in its power.

☞ Instructions and Forms for taking samples, and Terms for testing Fertilizers, Seeds, etc., for private parties sent on application.

☞ Parcels by Express, to receive attention, should be *prepaid.*

☞ Letters sent to individual officers are liable to remain unanswered in case the officer addressed is absent. All communications therefore should be directed simply to the

AGRICULTURAL EXPERIMENT STATION,
NEW HAVEN, CONN.

and all remittances should be made payable to the undersigned.

☞ Station Grounds, Laboratories and Office are on Huntington Street, five minutes walk west from Whitney Avenue and 1⅝ miles north of City Hall.

☞ Huntington Street may be reached by Whitney Avenue Electric Cars, which leave the corner of Chapel and Church Streets five times hourly, viz: on the striking of the clock and at intervals of twelve minutes thereafter.

☞ The Station may also be reached by taking Winchester Avenue Electric Cars, going north, which pass the Union R. R. Depot, and also start from corner Chapel and Church Streets, at intervals of sixteen minutes. Get off at Harriet street, whence five minutes walk eastward, crossing Prospect Street, and entering Huntington Street, brings to the Station.

☞ The Station has Telephone connection and may be spoken from the Central Telephone Office, 118 Court Street, or from Peck & Bishop's Office in Union R. R. Depot, New Haven.

☞ The Grass Garden, in charge of Mr. James B. Olcott, is near South Manchester, two minutes walk from the line of the Manchester Electric Cars, leaving City Hall Square, State Street, Hartford, every half hour. Conductors on this line can direct visitors to the Garden.

S. W. JOHNSON, *Director.*

CONTENTS.

REPORT OF THE TREASURER.

WM. H. BREWER, IN ACCOUNT WITH THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION FOR THE FISCAL YEAR ENDING SEPTEMBER 30TH, 1896.

RECEIPTS.

	For 9 months.	For 3 months.	Total.
State Comptroller, Agr. Appr.	$7,500.00	$2,500.00	$10,000.00
" " Food Appr.	1,875.00	625.00	2,500.00
United States Appr.	5,625.00	1,875.00	7,500.00
Analysis Fees due last year	170.00	....	170.00
" " this year	4,995.00	150.00	5,145.00
Damages from new layout of streets	400.00	....	400.00
Miscellaneous	70.72	....	70.72
	$20,635.72	$5,150.00	$25,785.72

EXPENDITURES.

	For 9 months.	For 3 months.	Total.
Salaries, State account	$6,345.83	$2,187.51	$8,533.34
" U. S. account	5,625.00	1,875.00	7,500.00
Labor	1,036.53	50.80	1,087.33
Publications	164.06	190.80	354.86
Postage	78.61	53.60	132.21
Stationery	163.59	26.80	190.39
Freight and Express	92.43	2.70	95.13
Coal	65.10	702.00	767.10
Gas	264.10	42.74	306.84
Water	147.00	....	147.00
Chemicals and Laboratory Supplies	977.09	69.74	1,046.83
Supplies—Agr., Hort., Bot., etc.	321.64	19.10	340.74
Fertilizers	153.51	2.79	156.30
Feeding Stuffs	73.46	16.04	89.50
Library	452.44	33.68	486.12
Tools and Machinery	33.94	19.20	53.14
Furniture and Fixtures	11.35	....	11.35
Scientific Apparatus	290.55	5.40	295.95
Travelling, by the Board	8.30	17.09	25.39
" " Staff	170.43	15.50	185.93
Telephone	162.35	....	162.35
Tobacco Exper.	79.65	12.50	92.15
Grass Exper.	1,000.00	....	1,000.00
Field Exper.	58.50	....	58.50
Fertilizer Sampling	448.98	5.45	454.43
Food Sampling	308.06	47.07	355.13
Bank Discount	19.03	....	19.03
Insurance	269.98	....	269.98
New lay-out of streets	42.88	25.20	68.08
Unclassified Sundries	26.84	....	26.84
New Buildings	390.82	....	390.82
Betterments	327.00	48.95	375.95
Repairs	165.83	121.18	287.01
Total Expenditures	$19,774.88	$5,590.84	$25,365.72
Balance to New Acct.			420.00
			$25,785.72

The accounts are rendered for periods of nine and three months, as were those of the Report of last year, to facilitate the comparison and correlation of the two Reports rendered to the State and the United States for their respective fiscal years. The classification of expenditures is, as far as is practicable, in accordance with that required to be given for the expenditures of the funds received from the United States, and recommended by the U. S. Dept. of Agriculture for the general use of all the stations in the country.

The new lay-out of streets has necessitated very considerable changes, costing much more than the $400 awarded as damages. Some of these changes, however, are of the nature of betterments and permanent improvements. Of the $420 balance carried to the new account, 331\frac{22}{100}$ are from this award and will pay probably about half of the amount required for the remaining changes that are necessary.

WM. H. BREWER, *Treasurer.*

Report of the Board of Control.

To His Excellency, O. Vincent Coffin, Governor of Connecticut:

The Board of Control of the Connecticut Agricultural Experiment Station herewith submits its report for the year ending October 31st, 1896.

Examination of Food Products.

Eleven hundred and thirty-two samples of Food Products have been purchased by agents of this Station, who have visited all sections of the State for this purpose. The samples thus collected have been suitably examined with reference to the presence of adulterants.

The necessary microscopic work has been entirely done by Mr. Winton, and the chemical work by Messrs. Winton, Ogden and Mitchell.

The first publication of this Station on Foods was issued in July, as Bulletin No. 123, and covers seventy-nine pages, giving a detailed account of the examination of eight hundred and forty-eight articles of food, thirty per cent. of which were adulterated.

As provided by statute, this will form a part of the forthcoming twentieth report of this Station.

Work for the Dairy Commissioner.

All the chemical work required by the Dairy Commissioner has been done in the laboratory of this Station, including examinations of nine samples of butter, fifteen of molasses and fifty-four of vinegar.

The Fertilizer Control.

During the months of April, May and June, members of the Station staff and Mr. C. L. Backus, of Andover, sampling agent of this Station, visited ninety-four towns and villages of this State and drew five hundred and eighty-nine samples of commercial fertilizers. These represented nearly all of the two hundred and fifty-five brands of these goods which have been entered for sale within the State.

Analyses of all these brands have been made in the chemical laboratory, by Messrs. Winton, Ogden and Mitchell, with the assistance of Mr. Lange. A manuscript copy of each analysis has been sent to the manufacturer and to each dealer from whom a sample of the goods was drawn.

The results of these fertilizer analyses have been tabulated and are ready for publication.

THE WORK OF THE CHEMICAL LABORATORY.

Besides the examination of Food Products, the work for the Dairy Commissioner and the analyses of the fertilizers just referred to, Messrs. Winton, Ogden and Mitchell have analyzed two hundred and eleven samples of fertilizers and manurial waste products, making the total number of fertilizer analyses four hundred and sixty-six.

In connection with vegetation experiments, the chemists have analyzed two hundred and seventeen crops of maize and forty-eight of oats, all grown in pots, and two crops of cucumbers, two of carnations, fifty-one of tomato vines and roots, four of tomato fruit, fourteen of lettuce and two of radishes, which were raised in the forcing-houses.

The chemists have also analyzed eight samples of maize and maize stover, and one hundred and sixteen of leaf tobacco, coming from the field experiments carried on by the Station.

Two hundred and eleven samples of vegetable seeds have been tested with regard to their vitality, in the interests of seedsmen and purchasers.

A very considerable number of determinations have also been made in testing analytical methods, chiefly concerning the determination of potash.

STUDY OF PLANT PROTEIDS.

During the year the work begun in 1895 on the proteids of leguminous seeds has been diligently prosecuted. The seeds studied have been yellow lupin, blue lupin, horse bean, lentil, yellow soy bean, Kiyusuki daidzu, soy bean, cow pea and white podded adzuki bean. Further study has been made of the maize kernel including determinations of the quantities of the several proteids in yellow corn.

THE WORK OF THE MYCOLOGIST.

The work of Dr. Sturgis during the past year is briefly as follows:

1. A continuation of the experiments of 1894 and 1895, upon the use of fungicides under various conditions, for the prevention of potato scab. This general subject was studied in the light of three separate experiments, and included investigations upon the danger to the crop arising from the use of scabby seed as compared with clean seed, infested land as compared with clean land, and barn-yard manure as compared with fertilizer chemicals. The fungicides tested were corrosive sublimate, sulphur and a new material called Lysol, highly recommended as a fungicide and insecticide by French and German investigators.

2. The susceptibility to potato scab of eight common root-crops and the application of fungicides to the soil by way of preventive treatment.

3. A test of the fungicidal value of dry Bordeaux mixture as compared with the usual liquid form.

4. Study of the supposed winter condition of the shot-hole fungus of peach, plum and apricot.

5. Study of a mildew attacking rose-bushes and distinct from the form common on rose leaves.

6. An investigation of the causes of the so-called "shelling" of grapes, and plans for treatment.

7. An investigation of a new and serious disease attacking growing tobacco in the South, and liable to occur in the North.

8. Continued work upon the San José Scale.

Horticultural Work.

Dr. Jenkins and Mr. Britton, with the coöperation of the chemical department, have continued the study of the relative availability of organic nitrogen in various forms, by vegetation experiments with maize and oats. Eighty-six experiments with maize grown in pots, charged with an artificial soil, and eighty-three in similar pots, charged with natural soils, have been carried out during the summer in a vegetation house built for the purpose.

The comparative availability of nitrogen in bone of different degrees of fineness, has been studied by forty-eight experiments with maize grown in cylinders sunk in the ground.

During the winter the fertilizer requirements of tomatoes, radishes and carnations were studied in the forcing-houses, the plants being grown for the purpose both in rich garden soil and also in a mixture of peat and anthracite coal ashes, to which fertilizer chemicals in the desired quantity were added.

Experiments have also been begun by Mr. Britton on the grafting of hickory trees.

Field Experiments.

Under the supervision of Dr. Jenkins, the extensive experiment on the effect of fertilizers upon quality and quantity of the tobacco crop, and the experiments noticed in our former reports on the growth of maize continuously on the same land, have been again repeated.

Three experiments on the fertilization of peach orchards have been undertaken, chiefly to study the effect of different amounts of potash salts and of the forms of nitrogen best adapted to the crop.

THE GRASS GARDEN.

Mr. J. B. Olcott has continued the study of native and foreign turf-making grasses in the grass garden at South Manchester, and during the year has visited the Sandwich Islands and Australia for the purpose of studying and collecting turf grasses. Turf gathered in these countries has been added to the large number of varieties already in the grass garden collected in England, France, Denmark and Austria, as well as in all parts of the United States.

STATION PUBLICATIONS.

The Nineteenth Report of this Station for the year 1895, a volume of three hundred and twenty pages, has been issued in an edition of twelve thousand copies and the seven thousand copies at the disposal of this Station, after satisfying our exchanges, have been distributed among the farmers of Connecticut. Less than fifty copies remain in our hands.

Bulletin No. 122, issued in May last, in an edition of four thousand copies, on cost of nitrogen, phosphoric acid and potash in Connecticut, contained sixteen pages.

Bulletin No. 123, issued in July, in an edition of five thousand copies, seventy-five pages, contained the first report of this Station on the Examination of Food Products.

The substance of these Bulletins will be reproduced in the Twentieth Report for 1896, now in course of preparation, which will contain a full account of all the work of the Station Staff during the State fiscal year.

ATTENDANCE AT FARM INSTITUTES AND OTHER FARMERS' MEETINGS.

In addition to the usual attendance at Farm Institutes and in response to requests, members of the Station Staff have attended a considerable number of meetings of farmers during the year, and read papers or made addresses.

CORRESPONDENCE.

During the year, nineteen hundred and thirty letters have been written by the Station Staff and eight hundred and fourteen manuscript reports of fertilizer and other analyses have been made.

MEETINGS OF THE BOARD.

During the year ending October 31st, the Board of Control has held three meetings.

All of which is respectfully submitted.

(Signed) WILLIAM H. BREWER, *Secretary.*

Nov. 1st, 1896.

REPORT ON FOOD PRODUCTS.

To his Excellency, O. Vincent Coffin, Governor of Connecticut:

As required by statute, I herewith submit the first Report of this Station upon Adulterated Food Products.

Very respectfully yours,

S. W. JOHNSON, *Director.*

The Conn. Agricultural Experiment Station,
New Haven, July 15th, 1896.

CONTENTS.

REPORT ON FOOD PRODUCTS.

The General Assembly of this State, at the January Session, 1895, passed an act regulating the manufacture and sale of food products; which was approved June 26th, 1895, and went into effect on August 1st of that year.

The text of the law is as follows:—

CHAPTER CCXXXV.

PUBLIC ACTS, JANUARY SESSION, 1895.

An Act regulating the Manufacture and Sale of Food Products.

Be it enacted by the Senate and House of Representatives in General Assembly convened:

Manufacture or sale of misbranded or adulterated food.

SECTION 1. It shall be unlawful for any person, persons, or corporation within this state to manufacture for sale, offer, or expose for sale, have in his or their possession for sale, or to sell, any article of food which is adulterated or misbranded within the meaning of this act.

Term food defined. Term misbranded defined.

SEC. 2. The term food, as used in this act, shall include every article used for food or drink by man, horses, or cattle. The term misbranded, as used in this act, shall include every article of food and every article which enters into the composition of food, the package or label of which shall bear any statement purporting to name any ingredient or substance as not being contained in such article, which statement shall be untrue in any particular; or any statement purporting to name the substance or substances of which such article is made, which statement shall not give fully the names of all substances contained in such article in any measurable quantity.

When an article shall be deemed to be adulterated.

SEC. 3. For the purposes of this act, an article shall be deemed adulterated:

First, if any substance or substances be mixed or packed with it so as to reduce or lower or injuriously affect its quality or strength;

Second, if any inferior substance or substances be substituted wholly or in part for the article;

Third, if any valuable constituent of the article has been wholly or in part abstracted;

Fourth, if it be an imitation of or sold under the name of another article;

Fifth, if it is colored, coated, polished, or powdered whereby damage is concealed, or if it is made to appear better or of greater value than it is;

Sixth, if it contains poisonous ingredients which may render such article injurious to the health of a party consuming it, or if it contain any antiseptic or preservative not evident and not known to the purchaser or consumer;

Seventh, if it consists, in whole or in part, of a diseased, filthy, decomposed, or putrid substance, either animal or vegetable, unfit for food, whether manufactured or not, or if it is in any part the product of a diseased animal, or of any animal that has died otherwise than by slaughter;

Provided, that an article of food product shall not be deemed adulterated or misbranded within the meaning of this act in the following cases:

(*a*) In the case of mixtures or compounds which may be now or from time to time hereafter known as articles of food under their own distinctive names, and not included in definition fourth of this section;

(*b*) In the case of articles labeled, branded, or tagged, so as plainly or correctly to show that they are mixtures, compounds, combinations, or blends;

(*c*) When any matter or ingredient is added to a food because the same is required for the protection or preparation thereof as an article of commerce in a fit state for carriage or consumption and not fraudulently to increase the bulk, weight, or measure of the food or to conceal the inferior quality thereof;

(*d*) When a food is unavoidably mixed with some extraneous matter in the process of collection or preparation.

Connecticut Agricultural Experiment Station to make analyses.

SEC. 4. The Connecticut Agricultural Experiment Station shall make analyses of food products on sale in Connecticut suspected of being adulterated, at such times and places and to such extent as it may determine, and may appoint such agent or agents as it deems necessary; who shall have free access, at all reasonable hours, for the purpose of examining, into any place wherein it is suspected any article of food adulterated with any deleterious or foreign ingredient or ingredients exists, and such agent or agents upon tendering the market price of said article may take from any person, firm, or corporation samples of any article suspected of

being adulterated as aforesaid, and the said station may adopt or fix standards of purity, quality, or strength when such standards are not specified or fixed by statute.

Notice to prosecuting officers.

SEC. 5. Whenever said station shall find by its analysis that adulterated food products have been on sale in the state, it shall forthwith transmit the facts so found to a grand juror or prosecuting attorney of the town in which said adulterated food product was found.

Report.

SEC. 6. The said station shall make an annual report to the governor upon adulterated food products, in addition to the reports required by law, which shall not exceed one hundred and fifty pages, and said report may be included in the report which said station is already authorized by law to make, and such annual reports shall be submitted to the general assembly at its regular session.

Appropriation.

SEC. 7. To carry out the provisions of this act, the additional sum of twenty-five hundred dollars is hereby annually appropriated to said Connecticut Agricultural Experiment Station, which sum shall be paid in equal quarterly installments to the treasurer of the board of control of said station, upon the order of the comptroller, who is hereby directed to draw his order for the same.

Penalty.

SEC. 8. Any person who, either by himself, his agent, or attorney, with the intent that the same may be sold as unadulterated, adulterates any food products for man, or horses, or cattle, or knowing that the same has been adulterated, offers for sale or sells the same as unadulterated, or without disclosing or informing the purchaser that the same has been adulterated, shall be fined not more than five hundred dollars, or imprisoned not more than one year.

Action not to be maintained on illegal sale.

SEC. 9. No action shall be maintained in any court in this state on account of any sale or other contract made in violation of this act.

SEC. 10. All acts and parts of acts inconsistent herewith are hereby repealed.

Approved, June 26th, 1895.

The fourth, fifth and sixth sections of this act lay certain duties upon this Station as follows:

1st. To make analyses of food products suspected of being adulterated.

2d. Whenever it shall find by its analysis that adulterated food products have been on sale, it shall forthwith transmit the facts so found to a prosecuting officer in the town where the adulterated food product was found.

3d. The Station shall make an annual report.

The law also provides that the Station may adopt or fix standards of purity, quality, or strength, when such standards are not specified or fixed by statute.

All articles used as food or drink by men, horses or cattle are included under the provisions of the law and are subject to the inspection and investigation of the Station. It is obvious that because of this wide scope of the law, and also because of the limited appropriation made for the work, it is quite impossible that the whole field should be covered in any one year.

That due diligence has been shown in examining food products during the twelve months covered by this report is shown by the work described on the following pages.

Authorized agents of this Station have visited forty cities and villages of Connecticut for the purpose of purchasing articles of food liable to adulteration.

These places are distributed as follows:

Litchfield County	3	places.
Hartford "	9	"
Tolland "	1	"
Windham "	5	"
New London "	5	"
Middlesex "	1	"
New Haven "	10	"
Fairfield "	6	"
	40	"

There have thus been secured 934 samples of food products of the following kinds:

Maple Syrup	72	samples.
Maple Sugar	7	"
Syrup	4	"
Cane Sugar	16	"

Comb Honey	12	samples.
Strained Honey	48	"
Lard and Lard substitutes	162	"
Pepper	114	"
Mustard	74	"
Cream of Tartar	103	"
Cereal Foods	9	"
Coffee	124	"
Milk	105	"
Cheese	72	"
Miscellaneous	25	"
	947	"

In collecting these samples no effort has been made to select places in which it might be supposed that adulterated goods would be most abundant, but it was rather sought to get as many different brands of each article as was possible. To this end the agents purchased from "fancy" groceries, as well as from the cheaper places which supply the poorer part of the population.

The State having already specially provided for the inspection of butter, molasses and vinegar by a dairy commissioner and his deputy, inspection of these three food products by the Station is uncalled for.

It should be said, however, that all samples drawn by the dairy commissioner or his deputy are referred by them to this Station for examination and report.

The examination of the samples bought by Station agents has been entirely done by Messrs. Winton, Ogden and Mitchell, as will be seen from their papers on the following pages.

In every case where certain proof of adulteration was found, the facts, as required by the law, have been forthwith transmitted to a grand juror or other prosecuting officer of the town or borough where the adulterated food products were sold.

The duties of this Station end here. In order to prosecute successfully it is necessary for the State not only to prove the sale of adulterated food products, but also to prove that the seller knew that the articles sold were adulterated.

MAPLE SYRUP AND MAPLE SUGAR.

By A. W. Ogden.

Maple syrup, obtained by evaporating the sap of the sugar maple, contains essentially the same sugars that exist in sugar made from sugar cane and beet root, but it is specially prized for its peculiar flavor. This flavor is said to be more or less successfully imitated, and, according to popular belief, it is quite possible to prepare, from the ordinary white or brown sugar of the stores, a syrup or a sugar which cannot be certainly distinguished from genuine maple syrup or maple sugar.

It is probable that genuine maple syrup or sugar may be melted with water and a large proportion of ordinary sugar to make a mixture which has enough maple flavor to be in demand and to be extensively sold as maple sugar or maple syrup.

In Table I, page 9, are given analyses of 61 samples of "maple syrup," bought by Station agents in 22 different cities and towns of this State.

Of most of these it is impossible to say whether or not they are genuine and unadulterated.

But the last eight samples in the table of analyses are certainly adulterated and consist wholly or in part of glucose syrup. The five samples which immediately precede in the table those marked adulterated, and which are numbered 5094, 5093, 5461, 5397 and 5043 contain some substance which has a strong right-handed polarization and is not "inverted" by the action of acids. Such a substance is not known in pure maple syrup or sugar, but a mixture of syrup with a moderate quantity of glucose would give the polarization observed in these samples.

Method of Testing Sugars and Syrups.

Sugar, syrup and honey are tested generally by the polariscope, other tests being made in special cases.

In our work one-half the normal quantity for polariscopic test* was dissolved in water and clarified when necessary with 1^{cc} each of alum cream and basic lead acetate solution. After making up the volume to 100^{cc} and filtering, the solution was polarized in a 200^{mm} tube. 50^{cc} of the solution were treated with 5^{cc} of strong hydrochloric acid, heated at 68° to 70° C. for ten minutes and polarized a second time, after inversion.

The results in the table are calculated in all cases to the normal quantity.

* 13.024 grams.

EXPLANATIONS OF THE TABLE OF ANALYSES.

The last column in Table I gives the per cent. of cane sugar deduced from the polarizations. This ranges in the "maple syrups" from 47 per cent. in No. 5371 to 66 per cent. in No. 5460. Most of the samples contain 60 per cent. or over. The other 30 per cent. is in some cases mostly and in all largely water, but besides cane sugar and water there are larger or smaller amounts of "invert sugar" (a mixture of "glucose" and "fructose" sugars), which always results when cane sugar solutions containing acids (juice or sap) are heated and boiled as in open pan sugar-making. A properly prepared solution of pure dry cane sugar polarizes +100 degrees. After heating with hydrochloric acid the cane sugar is changed to "invert sugar," which polarizes —36½° at a temperature of 15° C. In most cane sugars and in syrups containing cane sugar only, the same relation holds so that such a syrup, giving direct polarization of +50°, would polarize —18.25° after inversion and would accordingly contain 50 per cent. of cane sugar.

But sugars or syrups that already contain invert sugar, show in consequence a less direct +polarization and a greater —polarization than those which contain a like amount of cane sugar *without* invert sugar. Thus in the sample of maple syrup first in Table I the 56 per cent. of cane sugar corresponds to +56° of direct polarization and about — 19.3° after inversion. The difference—2.9 degrees—represents the polarizing effect of invert sugar, with small quantities possibly of other optically active substances.

Assuming, however, that cane and invert sugar are the only optically active things present, the amount of invert sugar is 1.44 per cent.

Table II, page 12, gives the analyses of seven samples of "Maple Sugar."

Whether these were made entirely from maple juice or are imitations of maple sugar cannot, in the present state of knowledge, be certainly determined by chemical examination.

They contain 10 to 15 per cent. of moisture.

TABLE I.—MAPLE SYRUPS.

Station No.	Label on Package.	Manufacturer, Producer, or Wholesaler.	Dealer.	Cost per Package.	Polarization. Direct.	Polarization. After Inversion.		Sucrose or Cane Sugar.
					Degrees	Degrees	Temperature. C.	Per cent.
5488	Pure Maple Syrup	Hildreth Bros. & Segelken, N. Y.	A. J. Finney, 202 Main St., Stamford	$0.22	+53.1	—22.2	19.0	56.0
5298	Leonard's Pure Vermont Maple Syrup	D. C. Leonard & Son, Wilmington, Vt.	Newton & Robertson, Hartford	.35	+56.7	—20.0	24.6	58.3
5096	Maple Syrup	C. L. Houghton & Co, Northampton, Mass.	Grocery, S. W. corner Wallace & Walnut Sts., New Haven	.25	+57.5	—17.6	27.8	57.7
5384	Golden Crown, Pure Sap Maple Syrup	Clark, Chapin & Bushnell, N. Y.	W. H. Bronson, 234 Main St., Ansonia	.25	+58.8	—20.2	21.3	59.3
5380	Golden Crown, Pure Sap Maple Syrup	Clark, Chapin & Bushnell, N. Y.	R. D. Baldwin, Bridge St., Winsted	.25	+58.8	—20.5	21.3	59.4
5302	The Vt. Maple Sugar Ex. &c. Guarantees This Maple Syrup Strictly Pure	The Vermont Maple Sugar Ex., Brattleboro, Vt.	H. J. Case & Co., Hartford	.35	+58.8	—21.6	24.0	60.8
5301	Warranted Strictly Pure Maple Syrup	B. Frank Steele & Co., Springfield, Mass.	Earnest Glaeser, Rockville	.25	+59.2	—19.6	25.0	59.7
5383	Maple Sap Syrup. Put up and Guar. by	Welch Bros. Maple Co., Burlington, Vt.	Waterbury Grocery Co., 163 Bank St., Waterbury	.25	+59.5	—20.7	22.2	60.3
5497	Irving's Vermont Maple Syrup		Fitch A. Hoyt, Stamford, Conn.	.22	+59.6	—21.9	18.8	60.6
5422	None	Not known	T. W. Potter, New London, Conn.	1.00*	+59.6	—21.5	21.6	60.8
5369	Pure Maple Syrup. Put up by	David H. Geer & Son, Boston, Mass.	Grocery, 234 E. Main St., Bridgep't	.12	+59.6	—20.6	21.8	60.2
5376	Pure Vermont Maple Syrup	D. Trubee & Co., Bridgeport, Conn.	E. L. Sullivan, 436 E. Main St., Bridgeport	.25	+60.0	—20.2	22.5	60.4
5092	Hazen's Vt. Maple Syrup, Warranted Pure		Gilbert & Thompson, New Haven	.45	+60.6	—20.1	26.0	61.6
5042	None	Not known	L. D. Chidsey, New Haven	.75 can	+60.3	—20.4	25.0	61.3
5381	Famous Vt. Maple Syrup. Strictly Pure	Clark, Chapin & Bushnell, N.Y.	N. W. Heater, Waterbury, Conn.	.20	+61.1	—20.2	22.3	61.4
5309	Pure Maple Syrup	The Vt. Maple Sugar Ex., Brattleboro, Vt.	H. I. Palmer, Norwich, Conn.	.75†	+61.5	—21.8	23.4	62.9
5097	None	Said to be Thompson, Northampton	D. S. Cooper Co., 470 State St., New Haven	.25	+61.7	—20.0	26.3	62.4
5499	Hampshire County Maple Syrup	Leslie, Dunham & Co., Pittsfield, Mass.	N.Y. Cash Grocery, Norwalk, Conn.	.20	+62.0	—22.0	18.3	62.3

* Gallon. † One-half gallon.

TABLE I.—MAPLE SYRUPS—*Continued.*

Station No.	Label on Package.	Manufacturer, Producer, or Wholesaler.	Dealer.	Cost per Package.	Polarization. Direct.	Polarization. After Inversion.		Sucrose or Cane Sugar.
					Degrees	Degrees	Temperature. C.	Per cent.
5312	Climax Pure Maple Syrup	C. T. & J. C. Joslyn, Waitsfield, Vt., and Malden, Mass.	J. P. Halloway, Norwich, Conn.	$0.30	+62.0	—20.9	23.4	62.6
5303	Maple Sap Syrup. Put up and Guaranteed by	Green Mountain Maple Asso.	W. W. Walker, Hartford	.24	+62 5	—21.0	24.7	63.4
5426	Maple Syrup	The Crystal Conserve Co., N. Y.	Logan Bros., Main St., Bridgeport	.10	+62.6	—21.3	21.9	63.1
5313	Vermont Maple Syrup. Warranted 1st Quality	J. H. Barker & Co., Rutland, Vt.	Welcome A. Smith, Norwich	.35	+62.6	—21.7	23.7	63.8
5385	Warranted Strictly Pure Vt. Maple Syrup		Dillon's Cash Grocery, Ansonia	.25	+62.8	—20.8	22.2	62.9
5387	Vermont Maple Syrup	Hildreth Bros. & Segelken, 28 & 30 W. Broadway, N. Y.	The Clarke & Stevens Grocery, Shelton	.35	+62 8	—20.7	22.8	63.6
5396	The Crystal Conserve Co. Maple Syrup	F. H. Leggett & Co., N.Y., Prop.	A. H. Armington, Danielson	.18	+62.8	—21.1	22.0	63.1
5098	Strictly Pure. Made in Wyndham Co., Vt.	Thompson & Cromack, Northamptor.	Berry & Bailey, 946 Grand Ave., New Haven	.25	+63.0	—19.5	27.5	63.3
5044	Pure Vt. Maple Syrup. Put up expressly for	D. M. Welch & Son, New Haven, Conn.	D. M. Welch & Son, New Haven	.22	+63.0	—20.0	26.8	63.6
5386	None	F. H. Pratt, Tolland, Mass.	J. C. O'Brien, Main St., Ansonia	.40	+63.0	—21.0	23.1	63.4
5379	Maple Syrup	The Crystal Conserve Co., N. Y.	McGraw & Baldwin, Danbury	.25	+63.1	—21.0	21.3	63.3
5311	None	J. C. Worth, Norwich	Wheeler Bros., Norwich	.30	+63.2	—22.2	22.5	63.6
5465	None		P. W. Hiller, New Britain	.15	+63.3	—21.2	22.9	63.8
5299	Mascot Brand, Pure Maple Syrup	R. N. Fitzgerald, 142 State St., Hartford	Purinton & Reade, Willimantic	.35	+63.4	—21.2	24.8	64.3
5095	Superb Pure Maple Syrup	Not known	Coe & Field, New Haven, Conn.	.25	+63.4	—20.7	26.6	64.4
5500	None	Not known	Betts & Farrington, Norwalk, Conn.	.10	+63.5	—22.0	19.0	63.5
5395	None	W. J. Lamb, W. Somerville, Mass.	W. H. Brown, Moosup	.25	+63.7	—20.6	21.5	63.2
5300	Pure Maple Syrup. Orange Co., Vt.	W. J. Lamb, W. Somerville, Mass.	Ransom Bros., Rockville	.30	+64.1	—20.9	24.8	64.6
5374	Pure Maple Syrup. Enosbury, Vt.	D. H. Geer & Son, Boston, Mass.	Store at 47 White St., Danbury	.15	+64.2	—21.5	22.5	64.5
5462	Warranted Strictly Pure Maple Syrup. Put up for	F. M. Hotchkiss, Meriden, Conn.	N. P. Lamontague, Meriden	.25	+64.3	—21.9	22.6	64.9
5372	Vermont Maple Syrup		Gustav. E. Friedrich, So. Norwalk	.30	+64.4	—21.6	22.0	64.4
5046	Warranted Pure Vt. Maple Syrup	Stoddard, Kimberly & Co., N. H.	H. S. Dailey, 97 Whalley Ave., N. H.	.35	+64.6	—20.7	27.4	65.5
5375	Green Mountain Maple Syrup. Pure and Delicious	Austin, Nichols & Co., N. Y.	Doran's Cash Grocery, Danbury	.25	+64.6	—22.2	22.5	65.4

TABLE I.—MAPLE SYRUPS—*Continued.*

Station No.	Label on Package.	Manufacturer, Producer, or Wholesaler.	Dealer.	Cost per Package.	Polarization. Direct.	Polarization. After Inversion.		Sucrose or Cane Sugar.
					Degrees	Degrees	Temperature. C	Per cent.
5463	Thompson's Absolutely Pure Maple Syrup	J. E. Thompson	Sovereigns' Trading Co., N. Britain	$0.25	+64.7	−19.6	23.3	63.7
5464	Warranted Strictly Pure Maple Syrup	G. W. Moseley & Son, Hartford	Lee Bros. & Co., New Britain, Conn.	.30	+64.8	−21.0	21.9	64.5
5045	Pure Maple Syrup. Woodstock, Vt.	F. P. Adams & Co., Boston, Mass.	P. Jente & Bro., Broadway, N. H.	.23	+65.1	−21.1	25.6	65.7
5447	Warranted Strictly Pure Maple Syrup	G. W. Moseley & Son, Hartford, Conn.	Hill Grocery, 552 Asylum St., H'tf'd	.28	+65.2	−23.3	18.9	65.7
5460	Home Brand, Warranted Strictly Pure Vermont Maple Syrup	Bryan, Miner & Reed, New Haven	E. F. Buhles, Meriden	.25	+66.4	−22.3	19.2	66.0
5371	Vermont Maple Syrup	J. H. Green, 150 Flushing Ave., Brooklyn, N. Y.	Conn. Am. Tea Co., 856 Main St., Bridgeport, Conn.	.10	+41.2	−21.2	22.5	47.0
5377	None	Unknown	Grocery, 87 White St., Danbury	.30	+49.6	−20.6	22.7	52.9
5094	Pure Maple Syrup	H. D. Gloyd, Charlestown, Mass.	J. H. Dore, 763 Grand Ave, N. H.	.23	+61.1	−11.7	25.6	55.5
5093	Thompson's Absolutely Pure Maple Syrup	J. E. Thompson	C. E. Hart & Co., 350 State St., "	.30	+71.0	− 8.7	26.0	60.8
5461	Pure Vermont Maple Syrup	James Butler, 406 Greenwich St., N. Y.	Russell Bros., Meriden	.10	+69.6	− 5.0	19.2	55.5
5397	Mayflower Brand Pure Maple Syrup	R. N. Fitzgerald, Hartford, Conn	Perkins & Bliss, Willimantic	.30	+74.3	− 5.9	22.8	60.5
5043	Pure Vermont Maple Syrup		Johnson & Bro., 411 State St., N. H.	.35	+72.1	− 0.2	25.3	55.1
	Adulterated "Maple Syrups," Consisting of or Containing Glucose Syrup.							
5316	The Champion Brand Pure Maple Syrup	C. A. Reed, Medford, Mass.	James M. Young, Preston	.25	+80.0	+18.9	22.0	
5370	Vermont Maple Syrup	J. H. Green & Sons, Brooklyn, N. Y.	Store cor. E. Main and Clarence Sts., Bridgeport	.10	+85.0	+37.6	22.1	
5388	Pure Maple Syrup for Family Use	Silas F. Jones, Hancock, Vt.	J. Burkhardt & Co., Shelton	.25	+93.7	+48.3	22.5	
5394	Said to be	W. J. Lamb, W. Somerville, Mass.	Quinnebaug Store, Danielson	.25	+95.0	+58.7	23.1	
5498	Pure Maple Syrup		Finney & Benedict, Norwalk	.25	+96.4	+37.7	20.3	
5279	Pure Maple Syrup for Family Use	Fournier & Schiller Co., Rochester, Vt.	H. Dion, Willimantic	1.00*	+97.4	+61.2	24.0	
5446	Hudson Brand Maple Syrup	Hudson M'f'g Co., 61 Hudson St., N. Y.	C. F. Cleaveland, Windsor Locks	.25	+100.0	+45.6	19.0	
5373	Thompson's Maple Syrup	259 Greenwich St., N. Y.	Chas. Starr, New Milford, Conn.	.25	+105.0	+50.9	21.5	

* Gallon.

Table II.—Maple Sugars.

Station No.	Label.	Producer or Wholesaler.	Dealer.	Cost per Package.	Polarization. Direct. Degrees.	Polarization. After Inversion. Degrees.	Polarization. After Inversion. Temperature. C.	Sucrose, or Cane Sugar.
5100	None	Not known	D. S. Cooper Co., 470 State St., New Haven	$0.12	+84.1	—28.8	25.0	85.9
5308	None	W. J. Lamb, W. Somerville, Mass.	Brainard & Bartlett, Putnam	.15	+85.8	—27.3	22.9	85.3
5099	Genuine Vt. Maple Sugar	C. T. & J. C. Joslyn, Malden, Mass.	Coe & Field, 422 State St., New Haven	.15	+86.1	—27.6	27.2	87.2
5304	None	W. J. Lamb, W. Somerville, Mass.	Ransom Bros., Rockville	.15	+87.5	—27.5	26.0	87.8
5382	None	Hildreth Bros. & Segelken, N. Y.	The Clark & Stevens Store, Shelton	.18	+87.7	—28.3	21.9	87.2
5389	Gem Pure Vt. Maple Sugar	Clark, Chapin & Bushnell, N. Y.	W. H. Bronson, 234 Main St., Ansonia	.15	+88.0	—28.3	22.5	87.6
5317	None	W. J. Lamb, W. Somerville, Mass.	H. D. Rallion, 45 Broadway, Norwich	.20	+88.4	—29.3	22.0	88.5

SUGARS.

By A. W. Ogden.

Three samples of granulated sugar, ten of powdered sugar and three of brown sugar, have been examined, with the results given in Table III.

Powdered sugar is sometimes suspected by purchasers of being adulterated with flour or terra alba because of a real or imagined lack of sweetness, but no evidence of adulteration has been found in any of the samples here examined.

The powdered and granulated sugars contain from 98 to 99.5 per cent. of pure sugar; the brown sugars, like the maple sugars, contain from 10 to 15 per cent. of moisture.

Table III.—Sugar.

No.	By Whom Sold.	Price. Cents per Pound.	Per cent. of Pure Sugar. (Sucrose.)
	Granulated Sugar.		
5051	Benjamin Blumenthal, 229 Market St., Hartford	6	99.0
5052	Isaac Lechner, 203 Front St., Hartford	5	99.2
5053	Joseph Malley, 137 Front St., Hartford	5	99.2
	Powdered Sugar.		
5057	——— Davis, 228 Shelton Ave., New Haven	8	98.4
5058	J. Casseriego, Cor. Starr St. and Shelton Ave., New Haven	8	99.4
5059	Voelcker Bros., Cor. Gibbs St. and Shelton Ave., New Haven	8	99.4
5060	I. Strack, Cor. Munson St. and Shelton Ave., New Haven	8	99.0
5061	A. C. Tillman, 7 Shelton Ave., New Haven	8	99.0
5062	A. A. Eissele, Cor. Henry St. and Dixwell Ave., New Haven	8	99.4
5063	C. Kipp, 292 Dixwell Ave., New Haven	8	99.4
5064	C. Richards, 181 Dixwell Ave., New Haven	10	98.8
5065	J. T. Pohlman, 140 Dixwell Ave., New Haven	....	99.2
5066	P. Jente & Bro., Broadway, New Haven	7	98.8
	Brown Sugar.		
5055	Joseph Malley, 137 Front St., Hartford	5	84.8
5055	Benjamin Blumenthal, 229 Market St., Hartford	5	89.2
5056	Isaac Lechner, 203 Front St., Hartford	5	84.8

"SYRUP."

Table IV gives analyses of four articles bearing this name. Nos. 5502, 5378 and 5278 are glucose syrups; No. 5501 is apparently a cane sugar syrup.

As no distinct claim is made regarding either of these articles they cannot be considered adulterated.

TABLE IV.—"SYRUPS."

Station No.	Name of Brand.	Manufacturer or Wholesaler.	Retail Dealer.	Cost per Package.	Direct Polarization.	Polarization after Inversion.	Temperature.
5501	Sold for Sugar Syrup		S. Comstock, Jr., 72 N. Main St., South Norwalk	$0.03 ½ pt.	+ 36.5	— 13.2	22.3
5502	Queen Syrup	G. Boyd & Sons, 8th and Cantrell Sts., Phila.	D. S. Davenport, S. Norwalk.	.25	+ 97.5	+ 68.2	22.0
5378	Queen Syrup	G. Boyd & Sons	P. D. Vroom, 5 Keeler Street, Danbury	.30	+113.8	+ 93.6	23.8
5278	Sold for Sugar Syrup	Halpin & Green, N. Y.	W. W. Walker, Hartford	.50 gall.	+129.4	+114.1	24.5

HONEY.

By A. W. Ogden.

Honey consists of the nectar of flowers elaborated by the bee and laid down in the cells of the honey comb.

This is in substance the definition given in the dictionaries and recognized by writers on food products and food adulterations.

It is a not uncommon practice to feed bees, when flowers are scarce, with sugar in some form to carry them along till they can get a full supply of nectar from flowers. But in order to lessen the work of the hive and so to increase production, cane sugar is sometimes fed abundantly and continuously when it is not at all essential to the bees.

This cane sugar, more or less converted by the bees into invert sugar, is laid down in the comb; but according to the definition given above, is not, strictly speaking, true honey.

Thus it happens, as in sample 5050 in Table V, p. 16, that "honey" bought in a comb which has not been removed from the frame into which it was built by the bees, and therefore, where direct adulteration by a dealer is in the nature of things impossible, may yet contain a large percentage amount of cane sugar. It was most probably taken by the bees from their artificial food and was laid down within the cells without conversion into invert sugar.

The buyer of honey, *in the comb*, therefore is not sure of getting honey made wholly from the nectar of flowers.

Invert sugar and glucose syrup are common adulterants of the "strained honey" of the shops and a dead bee or a fragment of comb floating on the surface is no sure sign that the liquid beneath is not glucose syrup with some coloring and flavoring matter.

Forty-eight samples of strained honey and twelve samples of comb honey have been bought by agents of the Station in nineteen cities and villages, and the results of their examination are given in the following table.

Honey in the Comb.

Table V contains 12 samples of this class. Of these we consider the first six, numbers 5610, 5611, 5049, 5105, 5486 and 5490, to be genuine.

TABLE V.—COMB HONEYS.

Station No.	Label.	Producer or Wholesaler.	Dealer.	Price per Package.	Polarization. Direct. Degrees.	Direct. Temperature C.	After Inversion. Degrees.	After Inversion. Temperature C.
	Probably genuine.							
5610	None.*	C. H. Chittenden, Killingworth, Conn.	A. B. Stevens, 61 Broadway, N. H.	$0.18	— 0.6	24.9	— 6.6	24.5
5611	" †	" " " "	" " " "	.18	— 4.7	25.0	—10.1	25.0
5049	"	Austin, Nichols & Co., Hudson St., N. Y.	Johnson & Bro., 411 State St., New Haven	.15	— 7.3	21.5	—14.1	24.7
5105	"	Said to come from Westville, Conn.	E. E. Nichols, 378 State St., New Haven	.25	— 6.2	21.5	— 9.2	24.7
5486	"	Not known	Geo. A. Ferris, 184 Main St., Norwalk	.18	— 6.7	23.8	—10.3	22.5
5490	"	" "	Betts & Farrington, Wall St., "	.20	— 9.7	23.3	—15.4	20.2
	Possibly from bees fed with Sugar.							
5104	None on box	On crate, J. E. Hetherington, Cherry Valley, N. Y.	Coe & Field, 422 State St., N. Haven	.20	—12.3	23.6	—15.4	25.0
5367	"	Not known	Wilcox & Adams, Winsted, Conn.	.18	—11.8	23.6	—14.2	24.9
5366	From the apiary of Ward Lamkin, Ledyard, N. Y. Comb Honey	Ward Lamkin, Ledyard, N. Y.	E. L. Sullivan, 436 E. Main St., Bridgeport, Conn.	.18	—16.4	23.4	—18.0	24.4
5365	None on box	From the apiary of F. Greiner, Naples, N. Y.	Foot Bros., W. Main St., Waterbury.	.18	—16.6	23.0	—17.8	24.3
5368	"	Not known	D. M. Welch & Son., New Haven	.10	—19.5	23.4	—20.5	24.0
	Containing Cane Sugar.							
5050	New England No. 7 apiary	H. D. Davis & Co., So. Newbury, Vt.	Johnson & Bro., 411 State St, New Haven	.15	+18.5	25.2	— 9.0	24.0

* From sumach, tulip and basswood.

† From sumach, and possibly some basswood.

The next five, numbers 5104, 5367, 5366, 5365, 5368, may represent "honeys" from bees fed more or less with sugar.

No. 5050 is probably from bees which had been abundantly fed with cane sugar in some form. It contains 20.8 per cent. of cane sugar.

The per cents. of ash in the four samples, Nos. 5049, 5105, 5104 and 5050, were .24, .26, .46, and .03 respectively.

Strained Honeys.

Table VI contains the tests of 48 samples of this class. Seven of them, as indicated in the table, are probably genuine. Thirty-four are suspected of representing honey from bees fed on sugar or of being adulterated with invert sugar.

Two others contain considerably larger amounts of cane sugar, which either came from the sugar on which the bees were fed or was added to the honey as an adulterant.

The last five in the table, Nos. 5360, 5270, 5273, 5314, 5352, are unquestionably adulterated with glucose syrup.

Samples numbered 5359, 5354 and 5363 contain 14.6, 29.3, and 23.1 per cent. of cane sugar respectively.

The per cents. of ash in samples numbered 5101, 5048, 5103, 5102, and 5091 are .20, .02, .09, .36, and .09 respectively.

A considerable number of samples of "honey" were in packages identical in form and size and bearing labels of the same size, form and wording, but the contents of these packages were nevertheless quite unlike in quality.

These are included in Table VII. The first column gives the numbers of the samples, with brackets enclosing those which were contained in packages of one kind; the second column gives the label, common to the packages, while the following columns give the results of the examination.

Thus it is seen that there were two samples, 5360 and 5425, both in packages (bottles) of the same shape and size and both bearing the label, "Pure California Honey, put up expressly for family or medical use." The label bore the picture of a busy bee-hive. One of these bottles contained glucose syrup (5360), and the other (5425) invert sugar or possibly honey made from bees fed with cane sugar.

There were five samples, 5352, 5467, 5492, 5494, and 5047, put up in glass "tumblers" of precisely the same size and shape,

TABLE VI.—STRAINED HONEYS.

Station No.	Label.	Manufacturer or Producer.	Dealer.	Price per package.	Polarization. Direct. Degrees.	Direct. Temperature, C.	After inversion. Degrees.	After inversion. Temperature, C.
	Probably Pure.							
5276	Pure Extracted Honey	Helen Johnson, Middle Haddam, Ct.	Hills & Co., Hartford, Conn.	$0.50	— 1.0	23.8	— 5.1	24.8
5485	Pure Honey	Wm. T. Gregory, Norwalk, Conn.	Finney & Benedict, Norwalk, Conn.	.25	— 3.6	22.8	— 8.4	24.0
5449	Choice Honey	C. A. Stanton, Newington, Conn.	J. A. Pilgard, 138 Front St., Hartford, Conn.	.25	— 5 1	23.8	—11.0	22.3
5467	Pure Honey	Not known	Rudolph Bros., Meriden, Conn.	.20	— 7.9	23.3	—11.2	22.0
5310	Choice Extracted Honey. Strictly Pure	E. C. Hazard & Co., New York	H. I. Palmer, Norwich, Conn.	.20	— 5.6	23.2	—16.5	24.0
5423	Pure Orange Blossom Honey. Eagle Brand	Not known	Doran's Cash Grocery, 150 Main St., Danbury, Conn.	.20	— 6 8	25.1	—15.6	22.4
5362	None	Sold for native honey	M. H. Tilley, Derby, Conn.	.18	— 7.2	23.8	—14.0	24.2
	Possibly from bees fed with sugar, or the honey adulterated with invert sugar.							
5355	None	Not known	J. B. Sullivan. E. Main St., Bridgeport	.20	—10.1	23.3	—14.1	24.7
5361	None	Said to be Lamb	L. P. & A. M. Guilfoile, Bank St., Waterbury	.20	—10.3	23.4	—14.7	24.2
5364	Pure California Honey	D. H. Geer & Son, Andrew Sq , Boston	J. B. Vallee, 21 Grand St., Waterbury	.25	—11.0	22.7	—16.2	23.6
5424	Choice Extracted Honey. Strictly Pure	E. C. Hazard & Co., New York	Waterbury Grocery Co., 163 Bank St., Waterbury	.25	—11.8	25.1	—14.5	22.5
5420	1 Pound Pure Honey	Not known	W. S. Chappell, 148 State St , New London	.25	—12.0	24.7	—17.3	22.5
5495	None	Said to be native from New Canaan	T. Leeds, Stamford, Conn.	.18	—12.4	22.6	—17.2	18.5
5492	Pure Honey	Said to be native	D. S. Davenport, N. Main St., South Norwalk	.18	—12.7	23.7	—16.9	21.2

TABLE VI.—STRAINED HONEYS—*Continued.*

Station No.	Label.	Manufacturer or Producer.	Dealer.	Price per package.	Polarization. Direct. Degrees.	Direct. Temperature, C.	After inversion. Degrees.	After inversion. Temperature, C.
5448	1 Pound Pure Honey	Said to be Phelps	C. F. Cleaveland, Windsor Locks	$0.25	−13.2	22.5	−16.1	18.4
5351	None	Said to be W. J. Lamb	M. S. Burgess, Derby Junction	.25	−13.4	23.3	−16.5	25.0
5315	Pure Honeysuckle Honey	W. J. Lamb	H. D. Rallion, Norwich	.25	−13.7	22.0	−16.1	24.4
5356	None	Said to be farmer's honey	McGraw & Baldwin, Danbury	.20	−13.9	22.8	−16.5	25.2
5421	None	Said to be Cal. honey. From Am. Grocery Co., New York	T. W. Potter, 72 State St., N. London	.25	−14.3	23.5	−19.1	22.9
5277	Pure Extracted White Clover Honey	H. A. Whittlesey, Newington, Conn.	Newton & Robertson, Hartford	.25	−14.4	24.0	−17.4	24.5
5496	None	Said to be native from New Canaan	W. & E. Osterbanks, Norwalk	.30	−14.6	22.0	−19.3	19.6
5494	Pure Honey	Not known	Addison Brown, Wall St., Norwalk	.20	−14.9	23.7	−17.6	22.9
5353	None	Said to be native from farmers	Chas. Starr, New Milford	.15	−15.1	23.3	−17.6	25.4
5357	Strained Honey	Francis H. Leggett & Co., New York	Logan Bros., Bridgeport	.25	−16.2	22.3	−19.4	25.0
5491	None	Not known	G. W. Raymond, Norwalk	.15	−16.6	22.9	−19.9	20.8
5101	Pure White Clover Honey	W. J. Lamb	S.S. Adams, 412 State St., New Haven	.15	−16.8	25.7	−19.1	26.5
5275	Pure Strained Honey	The Crystal Conserve Co., New York	Hills & Co., Hartford	.25	−17.3	23.5	−20.5	24.6
5358	None	Said to come from Leggett	Barnum & Reed, 307 Main St., Danbury	.25	−17.4	22.6	−18.7	24.6
5274	None. Sold for Orange Blossom	Hildreth Bros. & Segelken, New York	W. W. Walker, Hartford	.15	−17.6	24.5	−18.9	24.6
5048	Pure Clover Dell Honey	D. M. Welch & Son	D. M. Welch & Son, Congress Ave., New Haven	.10	−18.1	25.5	−21.3	24.1
5047	Pure Honey	Not known	F. H. Kearney, Cor. Hill and Congress Ave., New Haven	.15	−18.2	22.7	−19.6	23.7
5103	Pure White Cal. Honey	F. P. Adams & Co., Boston, Mass.	F. A. Basserman, 621 Grand Ave., New Haven	.25	−18.4	21.9	−20.2	24.4
5272	Pure Honeysuckle Honey	W. J. Lamb	F. Farrenkopf, Rockville, Conn.	.20	−18.4	24.0	−20.5	24.7

TABLE VI.—STRAINED HONEYS—*Continued.*

Station No.	Label.	Manufacturer or Producer.	Dealer.	Price per package.	Polarization. Direct. Degrees	Polarization. Direct. Temperature, C.	Polarization. After inversion Degrees.	Polarization. After inversion Temperature, C.
5489	Orange Blossom Honey, &c.	Leslie, Dunham & Co., Brooklyn, N.Y.	A. J. Finney, 202 Main St., Stamford	$0.25	−18.5	23.1	−23.1	22.2
5466	Choice Honey	C. A. Stanton, Newington	Sov. Trading Co., 282 Main St., New Britain	.18	−18.8	21.4	−21.5	22.2
5493	Pure Orange Blossom Honey. Eagle Brand	Not known	W. R. Bates, Norwalk, Conn.	.18	−19.0	22.8	−22.1	20.7
5271	None	Said to be Lamb	Ransom Bros., Rockville, Conn.	.20	−19.6	24.2	−19.8	24.7
5102	Pure Extracted Honey	H. D. Gloyd, Boston, Mass.	Daniel Dore, 577 Grand Ave., New Haven	.15	−20.4	23.0	−22.7	25.6
5425	Pure California Honey	Not known	Not known	.18	−20.8	24.8	−25.1	21.7
5091	Orange Blossom Honey, &c.	Leslie, Dunham & Co., Brooklyn, N.Y.	Gilbert & Thompson, New Haven	.30	−21.2	22.3	−24.0	26.1
5359	Pure Orange Blossom Honey. Eagle Brand	Not known	Village Store Co., E. Main St., Bridgeport	.18	+ 1.2	24.5	−18.2	23.6
	Contain Cane Sugar.							
5354	Pure Clover Honey	Vermont Maple Syrup Co., Bridgeport	D. Hallett, 470 E. Main St., Bridgeport	.20	+24.2	23.3	−14.5	23.7
5363	Durkee's Choice Extracted Clover Honey	J. W. Durkee & Co., New York	E. F. Platt, 37 E. Main St., Waterbury	.10	+15.0	23.2	−15.6	23.0
	Consist of or contain glucose syrup.							
5360	Pure California Honey (&c.)	Not known	M. Blanchette, S. Main St., Waterbury	.20	+30.2	23.5	+27.2	24.0
5270	Pure Strained California Honey	Hildreth Bros. & Segelken, New York	E. Glaeser, Rockville	.20	+38.4	23.3	+35.6	24.0
5273	Choice Clover Honey	Chas. Israel & Bro., New York	H. J. Case & Co., Hartford	.20	+43.2	24.7	+38.2	24.4
5314	Choice Golden Rod Honey (&c.)	Wm. Thompson, Wayne Co., N. Y.	W. A. Smith, Norwich	.25	+53.5	23.7	+50.5	23.8
5352	Pure Honey	Not known	79 White St., Danbury	.18	+58.8	23.6	+56.4	24.0

each bearing a label showy with flowers, with the highly idealized picture of a bee in the center, over the picture of a hive, and the words, "Pure Honey." "Trademark."

No two samples were alike in composition. One was probably pure honey, another was certainly glucose syrup, the three others were perhaps honey, but of doubtful purity.

TABLE VII.—SAMPLES OF HONEY PUT UP IN SIMILAR PACKAGES.

No.	Label of Packages.	Polarization. Direct. Degrees.	Polarization. Direct. Temperature, C.	Polarization. After Inversion. Degrees.	Polarization. After Inversion. Temperature, C.
5420	1 Pound Pure Honey. (Blown in	−12.0	24.7	−17.3	22.5
5448	bottle.)	−13.2	22.5	−16.1	18.4
5359	Pure Orange Blossom Honey.	+ 1.2	24.5	−18.2	23.6
5423	Eagle Brand	− 6.8	25.1	−15.6	22.4
5493		−19.0	22.8	−22.1	20.7
5360	Pure California Honey. Put up ex-	+30.2	23.5	+27.2	24.0
5425	pressly for family or medical use	−20.8	24.8	−25.1	21.7
5272	Lamb's Pure Honeysuckle Honey	−18.4	24.0	−20.5	24.7
5315		−13.7	22.0	−16.1	24.4
5352	Pure Honey	+58.8	23.6	+56.4	24.0
5467		− 7.9	23.3	−11.2	22.0
5492		−12.7	23.7	−16.9	21.2
5494		−14.9	23.7	−17.6	22.9
5047		−18.2	22.7	−19.6	23.7
5310	Choice Extracted Honey. E. C.	− 5.6	23.2	−16.5	24.0
5424	Hazard & Co.	−11.8	25.1	−14.5	22.5
5449	C. A. Stanton. Choice Honey,	− 5.1	23.8	−11.0	22.3
5466	Newington, Conn.	−18.8	21.4	−21.5	22.2
5091	Orange Blossom Honey. Leslie,	−21.2	22.3	−24.0	26.1
5489	Dunham & Co., Brooklyn, N. Y.	−18.5	23.1	−23.1	22.2

EXAMINATION OF LARD.

By A. L. Winton.

Pure Lard.

Pure lard is the fat of swine, separated from the animal tissue by the process of "rendering." It should contain less than one per cent of water and foreign matters.

The choicest lards are made from the whole "leaf," or from the residue, after rendering the leaf at low temperatures and expressing the "neutral lard" which is used in the manufacture of oleomargarine. A good quality of lard is also made from back-fat and leaf rendered together. Fat from the head and intestines goes to make cheaper grades.

Lards may be either kettle or steam-rendered; the kettle process being usually employed for the choicer fat parts of the animal, while head and intestinal fat furnish the so-called "steam lard." Steam lard, however, is sometimes made from the leaf, and on the other hand other parts than the leaf are often kettle-rendered. Kettle-rendered lard usually has a fragrant cooked odor and a slight color, while steam lard often has a strong animal odor.

Adulterations of Lard.

Bell (1881) stated that water is the only adulterant which came under his notice in England. Dietzsch (1883) cited water as the chief adulterant, but added that "American refined lard" is a mixture of hog fat, oleomargarine, stearin and beef tallow.

The celebrated case of McGeoch, Everingham & Co. vs. Fowler Bros., which was tried before the Chicago Board of Trade in 1883, developed the facts that the mixing of cotton seed oil, beef stearin, etc., with lard at that time was practiced in Chicago. The chief, and at present, apparently the only adulterants of lard in common use, are other cheaper fats, of which cotton seed oil and "stearin"* are the ones mostly used; the former especially

* By rendering at a low temperature, and subsequently straining and pressing, beef fat is separated into two parts; "oil," which finds use in the manufacture of oleomargarine or imitation butter, and "stearin," the more solid fat used in making lard substitutes or imitations.

because of its cheapness, the latter in order to give solid consistence to the mixture.

The misleading term "refined lard," which, until 1889, was used to designate imitations, composed largely of cotton seed oil and beef stearin, has since been abandoned, and such mixtures are now branded as "lard compounds."

N. K. Fairbank & Co. and Swift & Co. have gone a step further and manufacture, under the names of cottolene and cotosuet, mixtures of cotton seed oil and beef fat, which are not sold as imitations of lard, but as substitutes, under copyrighted trade names.

Neither of the materials used as lard adulterants are considered to be at all injurious to health. But the mixture of cotton seed oil and stearin is cheaper than pure lard, and by many people is considered inferior for culinary operations.

Methods of Detecting Lard Adulterations.

The most complete work on the subject of lard adulteration was published by Wiley as Part IV, Bulletin 13, of the U. S. Department of Agriculture, Division of Chemistry. In this are described in detail the processes used in the manufacture of lard and lard adulterants, the properties of these fats, the methods of identification, and the results of the examination of numerous samples of pure and adulterated lards, cotton seed oil, various stearins, etc.

Of the numerous methods which have been proposed for the detection of foreign fats, three have been selected as best suited for our purpose.

1.—Bechi's silver test as modified by Dudley is described in detail by Wesson, in a recent article on lard adulteration (Jour. Amer. Chem. Soc. xvii, 724). The author, whose experience in this kind of work has been very extensive, states that this is the best single test for cotton seed oil we have. In doubtful cases the lard should be treated with nitric acid, as recommended by Wesson.

2.—Hübl's Iodine absorption number: I have followed in all essentials Hübl's directions as given in Bulletin 13, Part IV, of the Division of Chemistry, U. S. Dept. of Agriculture, p. 462.

For weighing the fat, however, I have used, as recommended by Wesson, flat-bottomed glass cylinders, 10 mm. in diameter and 20 mm. high.

These weigh less than 2 grams and do not change weight perceptibly from one weighing to another.

Five to seven c.c. of the melted fat (according as the iodine number is high or low), are measured into a weighed cylinder from a delicate pipette. After cooling, the cylinder and fat are weighed and introduced into the glass-stoppered vial in which the subsequent operations are performed.

3.—Belfield's microscopic test modified by Gladding: The details of this process were kindly furnished by Mr. T. S. Gladding, and have since been published by him, Jour. Am, Chem. Soc. xviii, p. 189.

EXAMINATION OF LARD FROM THE CONNECTICUT MARKET.

One hundred and sixty-two samples have been collected by agents of the Station, in twenty-one cities and villages of Connecticut, between the third of October and twenty-third of November, 1895.

These samples fall into three classes:

1st.—Pure lard.

2d.—Lard substitutes, "compound lards," cottolene, cotosuet, etc., sold under their trade names, but not as pure lard.

3d.—Adulterated lard, or imitations sold as lard.

Some samples were evidently duplicates of well known brands, already examined, and were not tested.

Pure Lard.—In Table VIII are given the results of examination of sixty-four samples of this class.

The first six samples are stated to have been rendered by the butchers from whom they were purchased. The nine samples which follow them were probably all kettle-rendered. Of the remainder a considerable number were undoubtedly steam lards. The prices paid for these pure lards ranged from nine to fourteen cents per pound. The average price was 11.4 cents.

Bechi's test, applied directly, usually gave with these pure lards no color at all or only a slight color. In a few samples, probably steam lards, a decided purple color was obtained, but after purification of the fat by nitric acid as described by Wesson, Bechi's test produced only a slight coloration.

The highest iodine number is 68.3, the lowest 54.5. The lower numbers were found in the kettle-rendered samples. Microscopic examination in each case revealed the presence of the lard stearin in crystals, and in no case were the characteristic beef stearin forms present.

Lard Compounds and Lard Substitutes.—In Table IX are described eleven samples of this kind, sold for what they really were: that is, not pure lard, but fat mixtures resembling lard, and having the same culinary use. They are not adulterated goods, in accordance with provisions *a* and *b*, Section 3, of the Connecticut Pure Food Law of 1895. The prices of these lard substitutes and compounds ranged from 8 to 10 cents per pound.

All of these samples, when tested with Bechi's reagent, formed a mirror of reduced silver and became discolored, acquiring in some cases a dark brown, in others a purple black tint. Previous purification of the lard samples did not change the result.

The lowest iodine number found in any case was 81.5, the highest 92.6. Armour's lard compound, which was formerly so mixed as to have about the same

TABLE VIII.—PURE LARD.

Station No.	Brand.	Dealer.	Price per Pound in Cents.	Chemical Examination. Bechi Test.	Chemical Examination. Iodine Number	Microscopic Examination.
5294	Butcher's Lard	J. R. Allen, 122 W. Main St., Norwich	10	Colorless.	65.6	Lard Stearin.
5295	" "	Elijah Tracey's Market, Norwich	12	Slight Color.	64.2	" "
5318	" "	E. Dutton, Agt., Winsted	12	Colorless.	56.6	" "
5332	" "	Lockhart's Market, Main Cor. Grand St., Bridgeport	12	"	54.5	" "
5477	" "	Menz Market, 5 Pacific St., Stamford	12	Slight Color.	66.8	" "
5416	" "	W. C. Wade, State St., Hartford	10	Slight Brown.	59.9	" "
5306	Pure Lard, Kettle-rendered, White, Perry & Dexter, Worcester, Mass.	Brainard & Bartlett, Putnam	10	Colorless.	59.1	" "
5305	Pure Leaf Lard, White, Perry & Dexter, Worcester, Mass.	A. L. Allen, Norwich	13	"	60.8	" "
5346	Pure Kettle-rendered Lard, Meriden Provision Co.	West End Cash Market, 453 W. Main St., Waterbury	13	Slight Color.	60.3	" "
5411	Pure Lard, Meriden Provision Co.	J. Kerin, 62 North St., New Britain	10	Colorless.	64.1	" "
5409	" " " "	A. M. Bidwell, 344 Main St., Middletown	12	Slight Brown.	63.9	" "
5331	" " McElroy Bros., Bridgeport	White Front Market, 466 East Main St., Bridgeport	12	Colorless.	62.3	" "
5404	Kettle-rendered Pure Lard, Providence Beef Co.	W. S. Chappell, 148 State St., New London	10	"	65.2	" "
5337	Pure Leaf Lard, F. A. Bartram & Co., Bridgeport	McGraw & Baldwin, White St., Danbury	13½*	Slight Color.	58.5	" "
5119	Pure Lard, Plumb & Winton, Bridgeport	Manufacturer	....	Colorless.	65.0	" "
5284	" " C. H. Davis & Co., Norwich	J. A. Turner, Willimantic	10	"	65.6	" "
5391	" " " " "	Bodo Bros., Moosup	9	"	63.4	" "
5009	Choice Leaf Lard, Warranted Strictly Pure, S. E. Merwin & Son, New Haven	Manufacturer	14†	"	64.2	" "
5008	Choice, Strictly Pure Elm City Lard, S. E. Merwin & Son, New Haven	Manufacturer	12†	Light Brown.	66.3	" "
5020	S. E. Merwin & Son, New Haven	J. Casseriego, Shelton Ave., New Haven	12	"	67.7	" "
5010	"Pure" (Red Label), Sperry & Barnes, New Haven	L. D. Chidsey, Church St., New Haven	14†	Colorless.	63.5	" "

* In 3 pound pail. † In 5 pound pail.

TABLE VIII.—PURE LARD—*Continued.*

Station No.	Brand.	Dealer.	Price per Pound in Cents.	Chemical Examination. Bechi Test.	Chemical Examination. Iodine Number	Microscopic Examination.
5341	"Pure" (Red Label), Sperry & Barnes, New Haven	J. M. Bristol & Son, Central Market, Ansonia	12	Colorless.	59.5	Lard Stearin.
5017	Sperry & Barnes, New Haven	Henry Hahn, 1327 W. Chapel St., New Haven	12	Slight Color.	66.7	" "
5339	Steam Refined Lard, Sperry & Barnes, New Haven	E. D. Booth, 200 Main St., Birmingham	13	Colorless.	63.3	" "
5016	Sperry & Barnes, New Haven	Shelton Ave. Cash Store, 228 Shelton Ave., New Haven	12	Slight Color.	66.4	" "
5013	Sperry & Barnes, New Haven	P. Jente & Bro, Broadway, New Haven	11	" "	64.8	" "
5281	Pure Lard, Comstock, Providence, R. I.	Bert Thompson, Willimantic	12	Slight Color.§	61.6	" "
5113	Pure Leaf Lard, Swift & Co., Chicago	C. E Hart & Co. 350 State St., New Haven	14	Colorless.	61.6	" "
5110	" " " "	Grand Ave. Market, 830 Grand Ave., New Haven	12	Colorless.§	63.8	" "
5403	Pure Lard, Warranted, J. B. Mason & Sons, Providence	Joseph Kopp, 207 Bank St., New London	10	Colorless.	65.0	" "
5399	Pure Lard, J. B. Mason & Sons, Providence	W. A. Murray, 672 Bank St., New London	10	"	64 0	" "
5340	Warranted Pure Lard, The L. C. Bates Co., New Haven	P. McEnerney, 130 Main St., Birmingham	12	Slight Color.	65.8	" "
5392	Warranted Pure Lard, The L. C. Bates Co., New Haven	Holden Arnold, Willimantic	10	Colorless.	63.4	" "
5327	Warranted Pure Lard, The L. C. Bates Co., New Haven	Smith & Burns, Cor. Liberty and Keeler Sts., Danbury	12	"	62.7	" "
5334	Pure Lard, Lee & Hoyt, New Haven	Kinney's, Bank St., New Milford	13	Slight Color.	63.0	" "
5286	Pure Lard, G. H. Hammond, Indiana	Purinton & Reade, Willimantic	12	Colorless.	66.4	" "
5325	" " "	Chas. Starr, New Milford	13	"	62.9	" "
5479	" " "	Sam'l Comstock, Jr., 72 N. Main St., S. Norwalk	12	"	66.3	" "
5308	Warranted Pure Lard, Robinson Brand, John F. Crocker & Co., Boston	P. M. Leclair, Putnam	10	"	63.6	" "
5285	Pure Lard, North Packing & Provision Co., Boston	H. C. Hall, Willimantic	12	"	66.0	" "

§ After treatment with nitric acid.

TABLE VIII.—PURE LARD—*Continued.*

Station No.	Brand.	Dealer.	Price per Pound in Cents.	Chemical Examination.		Microscopic Examination.
				Bechi Test.	Iodine Number	
5288	Choice Grocery Lard, Strictly Pure, North Packing & Provision Co., Boston	J. S. Hennessy, Willimantic	10	Colorless.	64.5	Lard Stearin.
5280	Pure Lard, John P. Squire & Co., Boston	Frank Larrabee, Willimantic	12	"	65.4	" "
5480	Best Lard, Absolute Purity, Finest Quality, Geo. C. Napheys & Co., Philadelphia	W. & E. Osterbanks, 53 Main St., Norwalk	11½	Slight Color.§	66.3	" "
5453	Pure Lard, Armour & Co., Chicago	Patrick Costello, 153 Pratt St., Meriden	10	Slight Color.	68.3	" "
5109	Pure Leaf Lard, Armour & Co., Chicago	Booth Meat Co., 370 State St., New Haven	12	Colorless.	65.7	" "
5019	Pure Lily Leaf Lard, Nelson, Morris & Co., Chicago	Geo. M. Coombs, Whalley Ave., New Haven	12	"	67.7	" "
5454	Pure Lard, H. L. Handy, Springfield, Mass.	C. M. Shipple, 141 Turnbull St., Hartford	8	"	65.2	" "
5410	" " " " "	Boston Branch Grocery, 238 Main St., New Britain	12	"	66.5	" "
5287	" " J. B. Mason & Sons, Providence	H. Dion, Willimantic	12	"	65.7	" "
5324		McNamara, 396 E. Main St., Bridgeport	10	"	59.9	" "
5458		Pacnam & Cook. 26 W. Main St., Meriden	10	Colorless.§	63.2	" "
5473		Firmey & Benedict, 41 Wall St., Norwalk	12	Slight Color.	62.6	" "
5457		Wm. J. Cashmann, 133 Pratt St., Meriden	10	"	65.5	" "
5418		I. W. Buckley, Hartford	12	Colorless.	67.3	" "
5419	Kettle-rendered Lard	I. C. Duvan, Windsor Locks	12	"	64.2	" "
5414		H. Jonas, Temple St., Hartford	12	"	64.1	" "
5483		Geo. A. Ferris, 184 Main St., Stamford	10	Colorless.§	65.5	" "
5445		John A. Pilgard, 138 Front St., Hartford	10	Colorless.	61.2	" "
5015		F. H. Kearney, Cor. Congress Ave., and Hill St., New Haven	10	Slight Color.	65.8	" "
5107		Pagter Bros., 800 Grand Ave., New Haven	12	"	64.5	" "
5114		Coe & Field, 422 State St., New Haven	10	Slight Color.§	63.8	" "
5329		T. R. Hoyt & Co., 7 West St., Danbury	12	Colorless.	63.7	" "
5320		T. Kilmartin, 495 W. Main St., Waterbury	12	"	66.1	" "
5328		E. L. Sullivan, 436 E. Main St., Bridgeport	10	Slight Color.	66.6	" "

§ After treatment with nitric acid.

iodine number as pure lard, thus making Hübl's iodine absorption test of no value in detecting the presence of cotton seed oil, is now apparently compounded according to another formula.

The presence of beef stearin was readily detected by the microscope in every instance. Cottolene and cotosuet, which are claimed to be made of cotton seed oil and beef suet and to contain no lard, react like "compound lards" with the reagents mentioned.

Lard Compounds and Imitations, sold as Lard.—In Table X are given analyses of forty-three samples of this class. In every case the purchasing agent asked for lard and there was sold to him an imitation or substitute without any statement or hint that it was not pure lard. The prices paid ranged from seven to twelve cents per pound and averaged 9.3 cents.

TABLE IX.—LARD COMPOUNDS AND LARD SUBSTITUTES SOLD UNDER THEIR TRADE NAMES, BUT NOT AS PURE LARD.

Station No.	Brand.	Dealer.	Price per Pound in Cents.	Chemical Examination.		Microscopic Examination.
				Bechi Test.	Iodine Number	
5117	Refined Lard Compound, N. K. Fairbank & Co.	N. Stein, 811 Grand Ave., New Haven	10	Dark Brown.	91.5	Beef Stearin.
5108	Lard Compound, Armour & Co.	Booth Meat Co., 370 State St., New Haven	8	"	85.8	" "
5115	Superior Lard Compound, Armour & Co., Kansas City	Peoples' Market, 448 State St., New Haven	8	"	83.3	" "
5012	Lard Compound, Nelson, Morris & Co.	J. C. Kelley, Boulevard Cash Store, New Haven.	8	"	81.5	" "
5289	Lard Compound, G. H. Hammond	Holden Arnold, Willimantic	8	"	91.1	" "
5290	Superior Compound Lard, Swift & Co., Chicago	A. A. Trudeau, Willimantic	8	"	83.6	" "
5291	Royal Lard Compound, Whitford & Bartlett, Providence, R. I.	Bert. Thompson, Willimantic	8	"	87.1	" "
5116	Lard Compound, Stoddard, Kimberly & Co., New Haven	Geo. W. Cooper, junction Grand Ave. and St. John St., New Haven	10	"	87.6	" "
5112	Lard Compound	D. Dore, 577 Grand Ave., New Haven	10	Purple Black.	84.7	" "
5021	Cotosuet, Swift & Co., Chicago	P. Jente & Bro., Broadway, New Haven	10*	Dark Brown.	85.5	" "
5468	Cottolene, N. K. Fairbank & Co., Chicago	D. M. Welch & Son, Congress Ave., New Haven	8½*	"	92.6	" "

* In three pound pails.

TABLE X.—LARD COMPOUNDS SOLD FOR LARD.

Station No.	Dealer.	Price per Pound in Cents.	Chemical Examination.		Microscopic Examination.
			Bechi Test.	Iodine Number.	
5408	J. H. Shieferman, Main St., Middletown	9	Dark Brown.	91.9	Beef Stearin.
5406	W. J. Trevithick, Rapella Ave., Middletown	9	"	91.2	" "
5455	A. D. Cook, 56 Market St., Hartford	10	"	92.3	" "
5456	Chas. S. Kelley, 154 Front St., Hartford	10	"	90.5	" "
5118	Wallace St., next to R. R. Bridge, New Haven	10	"	91.7	" "
5475	Betts & Farrington, Wall St., Norwalk	12	"	93.4	" "
5345	——— 251 S. Main St, Waterbury	10	"	91.8	" "
5398	Wm. S. O'Brien, 729 Bank St., New London	8	"	95.5	" "
5402	S. D. Ameco, 64 Main St., New London	10	"	94.7	" "
5401	Geo. F. Barnstorf, 45 Main St., New London	10	"	86.5	" "
5349	M. M. Smith, Main St., Winsted	8	"	94.4	" "
5336	Mrs. Clancy, 925 Main St., Bridgeport	10	"	89.7	" "
5482	Lorenzo Dibble, N. Main St., S. Norwalk	7	"	95.7	" "
5407	Sam. Kennedy, 648 N. Main St., New Britain	10	"	87.3	" "
5405	Lee Bros. & Co., 500 Main St., New Britain	9	"	92.6	" "
5319	Branch York State Butter Co., 844 Bank St., Waterbury	9	"	87.0	" "
5321	Frank Pepe, 4 Middle St., Waterbury	10	Purple Black.	88.4	" "
5347	——— 843 Bank St., Waterbury	8	Dark Brown.	91.5	" "
5344	Ladd's, 96 S. Main St., Waterbury	10	"	94.6	" "
5342	John B. Vallee, 21 Grand St., Waterbury	10	Purple Black.	92.9	" "
5350	King's Market, Cor. Keeler and Liberty Sts., Danbury	10	Dark Brown.	80.0	" "
5338	P. D. Vroom, 5 Keeler St., Danbury	8	Purple Black.	89.4	" "

Table X.—Lard Compounds Sold for Lard—*Continued.*

Station No.	Dealer.	Price per Pound in Cents.	Chemical Examination.		Microscopic Examination.
			Bechi Test.	Iodine Number.	
5390	Geo. A. Robertson, 70 State St., Bridgeport	9	Purple Black.	87.6	Beef Stearin.
5333	——— 102 N. Washington Ave., Bridgeport	10	Dark Brown.	88.0	" "
5330	J. J. Donovan, Cor. E. Main and Steuben Sts., Bridgeport	9	"	77.1	" "
5326	D. Sullivan, 881 Main St., Bridgeport	10	Purple Black.	91.3	" "
5323	Centennial American Tea Co., 856 Main St., Bridgeport	10	"	90.5	" "
5322	D. Hallett, 470 E. Main St., Bridgeport	10	"	90.5	" "
5348	P. T. Gloster & Co., Main St., Winsted	10	Dark Brown.	90.9	" "
5400	T. Manning, 407 Bank St., New London	10	"	94.5	" "
5111	——— 40 (?) Walnut St., New Haven	10	"	82.4	" "
5011	H. C. Dingwall & Co., 68 Congress Ave., New Haven	9	"	90.1	" "
5459	Russell Bros., 2 Colony St., Meriden	8	"	92.4	" "
5471	New York Cash Grocery, N. Main St., Norwalk	7	"	81.1	" "
5474	W. R. Bates, Norwalk	7	"	94.5	" "
5412	C. H. Russell, New York Butter and Grocery House, 383 Main St., Hartford	9	"	90.2	" "
5415	Joseph Hagarty, 75 Front St., Hartford	10	Purple Black.	91.2	" "
5417	H. Bacharach, 13 Park St., Hartford	10	Dark Brown.	96.0	" "
5451	Foley's Market, 487 Main St., Hartford	10	"	89.6	" "
5452	E. M. Palmer, 124 Albany Ave., Hartford	10	"	89.6	" "
5413	John Bonora, Windsor Locks	10	Dark Green.	87.3	" "
5478	New York Grocery Co., 206 Main St., Stamford	8	Dark Brown.	94.7	" "
5484	A. J. Finney, 202 Main St., Stamford	9	"	96.0	" "
5014	Italian Grocery, cor. Oak and Factory Sts., New Haven	10	"	85.6	" "

EXAMINATION OF PEPPER.

By A. L. Winton.

A considerable part of the chemical work described in this paper was done by Mr. W. L. Mitchell.

Nature of Pepper.—Both the white and the black pepper of commerce are the fruit of *Piper nigrum*, a climbing perennial plant, indigenous to Malabar and cultivated in various other tropical countries.

The berries or peppercorns grow close to the stems in long spikes, twenty to fifty berries in each spike, and change color as they ripen, from green to red and finally to black.

The black peppercorns of commerce are prepared by picking and drying the unripe spikes as soon as some of the berries begin to turn red. During the drying process the berries shrivel somewhat and turn black.

"White peppercorns" are the ripe berries from which the outer shell has been removed. They are grey in color and have a smooth surface. White pepper is not so pungent as the black kind, but is considered by many to have a finer flavor.

Long pepper, although produced by a plant (*Piper longum*) belonging to the same genus as the true pepper, is very different in its looks and flavor. The small berries are very closely crowded together in elongated clusters often an inch or more in length. It has a spicy taste, but none of the fine flavor of true pepper, to which it is sometimes added as an adulterant. Long pepper is apt to have earth adhering to it.

Cayenne, often called "red pepper," is the fruit of several species of *Capsicum* quite similar to our garden peppers and is radically different from the kinds of pepper already named. It is also used as an adulterant of black pepper, to restore the "bite," which has been lost by the addition of tasteless foreign matters.

Pepper is the most important commercially of all the spices and condiments. It is almost entirely imported in the form of peppercorns, which are admitted free of duty.

According to the Report on "Imports for Consumption into the United States, 1894 and 1895," prepared by the Bureau of Statistics, U. S. Treasury Department, 19,937,422 pounds of whole pepper, having a value (at four cents per pound) of

$791,853.93, were brought into the United States during the year 1895. A larger quantity of pepper was imported than of any other single spice or condiment, and the money value of the imported pepper was more than one-third of all unground spices taken together.

Assuming that all this pepper is annually consumed in the country and that Connecticut consumes a quantity proportional to the population (one per cent.), nearly 200,000 pounds must be annually used in the State.

The wholesale price of this, unground, would be nearly $8,000, but the retail price would be $56,000. This does not take into account the enormous quantities of adulterants, for which the consumer usually pays about the same price as for pure pepper.

The Adulteration of Pepper.—Ground pepper, the form in which most of the pepper is sold to consumers, is perhaps the most extensively adulterated of all food products. The list of things which have been used as adulterants includes bran, hulls and other by-products from wheat, maize, rice, oats, buckwheat and other grains, ground linseed, olive and rape seed cake, shells (often roasted or charred) of cocoanut, almonds and other nuts, sawdust, mustard husks, cayenne, long pepper, pepper shells, terra alba.

In order to get a proper mixture of light and dark particles, it is customary to use two or more adulterants, the one dark, the other light-colored; as for example: Roasted cocoanut shells and wheat middlings; buckwheat hulls and buckwheat middlings.

Cayenne reinforces the pungency which has been reduced by dilution. Mustard husks also give a certain "bite" to the mixture.

Wheat or buckwheat middlings furnish adulterants for white pepper which closely resemble the genuine pepper in appearance.

Pepper shells or dust consists of the hulls removed from white pepper with adherent dirt and often other waste material.

Examination of Samples of Pepper from the Connecticut Market.

One hundred and fourteen samples have been bought by our sampling agents from stock sold in bulk as well as in manufacturers' packages. The results of the examinations appear in the following tables and discussion:

METHODS OF EXAMINATION.

Microscopic Examination.—A portion of the sample was first viewed in water with ordinary illumination, using magnifying powers of 74 and 392 diameters. The character and size of the starch granules were noted and the results supplemented by examination with polarized light and also by viewing portions treated with iodine. The foreign tissues could often be identified without use of clearing agents.

The same portion which had been viewed directly was then treated with potash and again examined.

The crude fiber separated in the course of chemical analysis furnished material in which much of the denser tissues, such as "stone cells," was brought out distinctly and could be easily identified. The presence of charcoal or charred shells was also shown in this material, as it remains black after the treatment with acid and alkali, while the tissue of genuine pepper and of most adulterants, even buckwheat hulls, is of a light brown color. The presence of charred material was confirmed by bleaching tests with nitric acid and chlorate of potash.

Chemical Analysis.—Water, ether extract, fiber and ash, were determined by the methods which are used for the analysis of feeding stuffs. The drying in hydrogen was continued until constant weight was secured, which required about eight hours. The loss represents not only water, but also a part of the volatile oil. The extraction with absolute ether was complete at the end of eight hours. The same weighed portion was used for determination of water, ether extract and fiber.

The ether extract from pure pepper consists of piperine and resin, and the former invariably crystallizes out from the resin on cooling; but when the pepper is adulterated with stuff which contains fat or oil, the latter may completely hide the piperine crystals if it does not prevent their forming in the extract. We regard the absence of crystals in the ether extract as certain evidence of adulteration.

If the fat or oil introduced in the adulterant brings up the weight of ether extract to the amount which is found in pure pepper, a nitrogen determination in the extract from 10 grams of pepper will disclose its real nature.

Pure piperine contains 4.91 per cent. of nitrogen, but the ether extract of pepper consists in part of resin, which lowers the percentage considerably. Thus a sample of pure white pepper gave an ether extract containing 3.25 per cent. nitrogen, and of pure black pepper 2.64 per cent. In adulterated samples the ether extract had less than two per cent. of nitrogen.

Adulterated peppers, as a rule, contain: 1. Either less ether extract, or, 2. less nitrogen in the ether extract, or, 3. more fiber, or, 4. more mineral matter than pure ground pepper. It would be difficult to find adulterants which could be used in any considerable quantity and yet fail to be detected by one or more of these tests.

Pure Black Pepper.—In Table XI are grouped all those samples, fifty-nine in number, in which no foreign substance was detected with the microscope and which within reasonable limits agree in chemical composition with samples of undoubted purity.

It is possible that some of these samples are adulterated with

TABLE XI.—PROBABLY PURE BLACK PEPPER.

Station No.	Brand (taken from label on package in which goods were sold).	Dealer.	Price paid per ¼ pound. Cents.	Microscopic Examination.	Chemical Examination. Water.	Ether Extract.	Fiber.	Ash.
	Peppercorns ground at Station.							
5623	West Coast Sumatra Black Pepper		--	Pepper Starch and Tissue	10.33	8.30	11.49	4.85
5631	Singapore Black Pepper		--	" " "	10.74	7.57	12.07	3.74
	Ground Pepper in labeled packages.							
5568	Absolutely Pure Pepper. D. & L. Slade Co., Boston	Holden Arnold, Willimantic	10	" " "	11.24	7,66*	12.48	4.21
5071	Pure Pepper, warranted strictly pure Bennett, Sloan & Co.	Geo. M. Coombs, 195 Whalley ave., New Haven	10	" " "	10.72	7.02	14.30	4.96
5566	S. I. Specially Imported Ground Shot Pepper. Thurber Whyland Co., New York	C. D. Strickland, South Manchester	10	" " "	8.77	6.72	11.39	4.39
5567	Pepper. O. H. Blanchard	H. Dillon, Willimantic	10	" " "	10.18	7.26	13.10	4.71
5569	Genuine Malabar Black Pepper. Bennett, Simpson & Co., London	Waterbury Grocery Co., 163 Bank street, Waterbury	10	" " "	8.69	8.09	12.84	4.65
5570	Pure Pepper. Boardman & Sons., Hartford	J. Kerin, 62 North St., New Britain	10	" " "	10.63	7.84	12.86	4.10
5573	Crescent Mills Pure Pepper. John P. Augur, New Haven	Foote & Westwood, West Main street, Waterbury	10	" " "	10.13	7.65	10.90	3.90
5574	Blue Ribbon Pure Black Pepper. Austin, Nichols & Co., New York	Geo. Farley, Putnam	10	" " "	11.89	8.15	12.72	4.60
5576	Pepper. Lincoln, Seyms & Co., Hartford	E. F. Platt, 37 E. Main St., Waterbury	10	" " "	10.89	7.11	12.85	4.82
5577	Ground Black Pepper, warranted pure. Bryan, Miner & Read, New Haven	P. McEnerney, Main St., Birmingham.	10	" " "	9.36	7.30	12.70	4.17
5581	Pure Black Pepper. Bryan, Miner & Read, New Haven	Holden Arnold, Willimantic	10	" " "	11.18	7.81	15.41	5.23
5583	XXX Pepper. E. R. Durkee & Co., New York	Thomas Nolan 250 Pratt St., Meriden	10	" " "	12.23	7.62	12.84	5.75
5585	Red Shield Pepper. Jas. G. Powers & Co., New York	G. A. Ray, Norwich	9	" " "	11.34	8.33	14.50	5.88
5588	Pure Pepper. Clark, Chapin & Bushnell, New York	R. D. Baldwin, Bridge St., Winsted	10	" " "	10.79	8.33	13.23	5.61

* 2.64% nitrogen in ether extract.

TABLE XI.—PROBABLY PURE BLACK PEPPER—*Continued.*

Station No.	Brand (taken from label on package in which goods were sold).	Dealer.	Price paid per ℔ pound. Cents.	Microscopic Examination.	Chemical Examination. Water.	Ether Extract.	Fiber.	Ash.
5590	Pure Pepper, Adams & Howe, New York	—— 79 White St., Danbury	10	Pepper Starch and Tissue	8.30	8.34	14.48	5.93
5591	Pure Black Pepper. W. H. Mansfield & Co., Putnam, Conn.	W. H. Mansfield & Co., Putnam	10	" " "	11.30	7.96	12.73	4.46
5592	Pure Pepper. Union Spice Co.	Union Pacific Tea Co., 253 Main street, Danbury	10	" " "	11.04	7.79	12.67	5.74
5593	Pure Pepper. Swain, Earle & Co., Boston	James M. Young, Preston	10	" " "	11 00	7.32	12.80	4.22
5595	Strictly Pure Pepper. Barnum & Reed, Danbury	Barnum & Reed, 307 Main St., Danbury	12	" " "	10.26	6.62	13.53	4.68
5596	Strictly Pure Pepper. L. Battey & Son, Moosup	L. Battey & Son, Moosup	8	" " "	9.69	7.09	13.70	3.94
5597	Strictly Pure Pepper. C. H. Lyon, New London	C. H. Lyon, 42 Coit St., New London	10	" " "	10.41	6.76	12.23	3.97
5598	Pepper. Grand Union Tea Co., New York	Grand Union Tea Co., 237 Main street, Birmingham	10	" " "	11.34	8.11	13.63	5.56
5599	Strictly Pure Pepper, Excelsior Mills. A. R. R. Palmiter	George M. Spring, 214 Main St., Birmingham	12	" " "	11.06	8.06	12.60	5.87
5600	Pure Pepper. E. P. Hornick, New York	John P. Murphy, Norwich	10	" " "	10.19	7.46	12.17	5.62
	Ground Pepper sold in bulk.							
5516		—— 793 Bank St., Waterbury	10		10.48	7.70	12.82	5.75
5518		Corkey & Gannon, 29 Main St., New London	8		10.61	7.91	14.22	5.78
5521		—— 152 E. Main St., Bridgeport	10		11.97	8.60	11.83	6.58
5522		Dillon's Cash Grocery Store, 158 Main St., Ansonia	7		10.38	9.09	13.79	5.90
5524		M. Ahern, 160 Pratt St., Meriden	10		11.85	7.57	12.09	4.36
5528		W. H. Brown, Moosup	10		10.18	8.02	11.86	4.45
5529		D. E. Ketcham & Co., 33 Elm St., Danbury	8		11.61	7.34	11.09	4.37
5530		James M. Young, Preston	10		10.84	7.45	13.29	4.21
5532		Fred. H. Lewis, 98 W. Main St., Meriden	8		11.71	7.40	8.57	4.20

TABLE XI.—PROBABLY PURE BLACK PEPPER—*Continued.*

Station No.		Dealer.	Price paid per pound. Cents.	Microscopic Examination.	Chemical Examination.			
					Water.	Ether Extract.	Fiber.	Ash.
	Ground Pepper sold in bulk.							
5536		McGraw & Baldwin, White St., Danbury	8		11.30	8.51	11.20	5.39
5538		Purinton & Reade, Willimantic	10		11.58	7.25	14.66	6.12
5539		—— 102 N. Washington Ave., Bridgeport	10		10.71	7.46	13.81	4.41
5540		Johnson's Cash Grocery, Main street, Winsted	10		10.29	7.76	13.44	5.87
5547		H. C. Hall, Willimantic	10		12.13	8.12	12.50	5.02
5551		Keeney Bros.	8		11.31	7.59	12.70	4.57
5552		W. S. Chappell, 148 State St., New London	10		11.21	8.13	11.52	3.79
5553		G. A. Ray. Norwich	5		9.63	8.64	14.13	6.10
5557		P. M. Leclair, Putnam	10		9.37	7.12	13 85	4.57
5558		D. W. Lawton, Main St., Winsted	12		9.47	7.62	13.83	6.00
5559		James Sullivan, Putnam	10		10.31	7.96	11.37	4.99
5560		The Clark & Stevens Cash Grocery, Howe St., Shelton	8		9.80	7.57	12 84	4.21
5562		Putnam Mfg. Co. Stores, Putnam	10		9.17	8.22	12.89	4.97
5563		T. Kilmartin, 495 W. Main St., Waterbury	9		10.47	8.28	13.70	5.78
5564		M. H. Tilley, Main St., Birmingham	8		9.84	7.40	13.45	4.58
5571		W. A. Murray, 672 Bank St., New London	5		10 51	7.18	13.18	5.20
5507		Finney & Benedict, 41 Wall St., Norwalk	10		11.23	7.46	12.22	4.99
5506		Addison Brown, Norwalk	10		10 76	7.30	13.06	4.15
5504		Betts & Farrington, Norwalk	10		11.02	7.83	12.27	4.77
5067		Henry S. Dailey, 97 Whalley Ave., New Haven	10		11.08	7.86	11.33	4.45
5068		F. H. Kearney, cor. Hill St. and Congress Ave., New Haven	8		10.92	7.20	11.42	4.40
5070		Henry Hahn, 1327 West Chapel St., New Haven	9		10.90	8.00	12.88	4.80
5520		Jacob Walz, 54 Temple St., Hartford	10		11.22	6.59	15.52	6.42
5549		John B. Vallee, 21 Grand St., Waterbury	10		10.23	8.80	12.41	6.30

Table XI.—Probably Pure Black Pepper—*Continued.*

Station No.	Brand (taken from label on package in which goods were sold).	Dealer.	Price paid per ℔ pound. Cents.	Microscopic Examination.	Chemical Examination. Water.	Ether Extract.	Fiber.	Ash.
5590	Pure Pepper, Adams & Howe, New York	—— 79 White St., Danbury	10	Pepper Starch and Tissue	8.30	8.34	14.48	5.93
5591	Pure Black Pepper. W. H. Mansfield & Co., Putnam, Conn.	W. H. Mansfield & Co., Putnam	10	" " "	11.30	7.96	12.73	4.46
5592	Pure Pepper. Union Spice Co.	Union Pacific Tea Co., 253 Main street, Danbury	10	" " "	11.04	7.79	12.67	5.74
5593	Pure Pepper. Swain, Earle & Co., Boston	James M. Young, Preston	10	" " "	11 00	7.32	12.80	4.22
5595	Strictly Pure Pepper. Barnum & Reed, Danbury	Barnum & Reed, 307 Main St., Danbury	12	" " "	10.26	6.62	13.53	4.68
5596	Strictly Pure Pepper. L. Battey & Son, Moosup	L. Battey & Son, Moosup	8	" " "	9.69	7.09	13.70	3.94
5597	Strictly Pure Pepper. C. H. Lyon, New London	C. H. Lyon, 42 Coit St., New London	10	" " "	10.41	6.76	12.23	3.97
5598	Pepper. Grand Union Tea Co., New York	Grand Union Tea Co., 237 Main street, Birmingham	10	" " "	11.34	8.11	13.63	5.56
5599	Strictly Pure Pepper, Excelsior Mills. A. R. R. Palmiter	George M. Spring, 214 Main St., Birmingham	12	" " "	11.06	8.06	12.60	5.87
5600	Pure Pepper. E. P. Hornick, New York	John P. Murphy, Norwich	10	" " "	10.19	7.46	12.17	5.62
	Ground Pepper sold in bulk.							
5516		—— 793 Bank St., Waterbury	10		10.48	7.70	12.82	5.75
5518		Corkey & Gannon, 29 Main St., New London	8		10.61	7.91	14.22	5.78
5521		—— 152 E. Main St., Bridgeport	10		11.97	8.60	11.83	6.58
5522		Dillon's Cash Grocery Store, 158 Main St., Ansonia	7		10.38	9.09	13.79	5.90
5524		M. Ahern, 160 Pratt St., Meriden	10		11.85	7.57	12.09	4.36
5528		W. H. Brown, Moosup	10		10.18	8.02	11.86	4.45
5529		D. E. Ketcham & Co., 33 Elm St., Danbury	8		11.61	7.34	11.09	4.37
5530		James M. Young, Preston	10		10.84	7.45	13.29	4.21
5532		Fred. H. Lewis, 98 W. Main St., Meriden	8		11.71	7.40	8.57	4.20

TABLE XI.—PROBABLY PURE BLACK PEPPER—*Continued.*

Station No.		Dealer.	Price paid per ¼ pound. Cents.	Microscopic Examination.	Chemical Examination.			
					Water.	Ether Extract.	Fiber.	Ash.
	Ground Pepper sold in bulk.							
5536		McGraw & Baldwin, White St., Danbury	8		11.30	8.51	11.20	5.39
5538		Purinton & Reade, Willimantic	10		11.58	7.25	14.66	6.12
5539		—— 102 N. Washington Ave., Bridgeport	10		10.71	7.46	13.81	4.41
5540		Johnson's Cash Grocery, Main street, Winsted	10		10.29	7.76	13.44	5.87
5547		H. C. Hall, Willimantic	10		12.13	8.12	12.50	5.02
5551		Keeney Bros.	8		11.31	7.59	12.70	4.57
5552		W. S. Chappell, 148 State St., New London	10		11.21	8.13	11.52	3.79
5553		G. A. Ray. Norwich	5		9.63	8.64	14.13	6.10
5557		P. M. Leclair, Putnam	10		9.37	7.12	13 85	4.57
5558		D. W. Lawton, Main St., Winsted	12		9.47	7.62	13.83	6.00
5559		James Sullivan, Putnam	10		10.31	7.96	11.37	4.99
5560		The Clark & Stevens Cash Grocery, Howe St., Shelton	8		9.80	7.57	12 84	4.21
5562		Putnam Mfg. Co. Stores, Putnam	10		9.17	8.22	12.89	4.97
5563		T. Kilmartin, 495 W. Main St., Waterbury	9		10.47	8.28	13.70	5.78
5564		M. H. Tilley, Main St., Birmingham	8		9.84	7.40	13.45	4.58
5571		W. A. Murray, 672 Bank St., New London	5		10 51	7.18	13.18	5.20
5507		Finney & Benedict, 41 Wall St., Norwalk	10		11.23	7.46	12.22	4.99
5506		Addison Brown, Norwalk	10		10 76	7.30	13.06	4.15
5504		Betts & Farrington, Norwalk	10		11.02	7.83	12.27	4.77
5067		Henry S. Dailey, 97 Whalley Ave., New Haven	10		11.08	7.86	11.33	4.45
5068		F. H. Kearney, cor. Hill St. and Congress Ave., New Haven	8		10.92	7.20	11.42	4.40
5070		Henry Hahn, 1327 West Chapel St., New Haven	9		10.90	8.00	12.88	4.80
5520		Jacob Walz, 54 Temple St., Hartford	10		11.22	6.59	15.52	6.42
5549		John B. Vallee, 21 Grand St., Waterbury	10		10.23	8.80	12.41	6.30

pepper shells, but not with appreciable quantities of other foreign matters. Twenty-six of these samples were sold in packages bearing the name and address of the manufacturers, and thirty-three were sold by grocers in bulk.

The lowest per cent. of ether extract found in any sample was 6.62. The highest per cents of fiber and ash were 15.41 and 6.42 per cent. respectively.

Adulterated Black Pepper.—In Table XII are given results of examinations of twenty-nine samples of this kind, seven sold in packages bearing the name of the manufacturer or dealer, and twenty-two sold in bulk.

All of these samples were condemned both by the chemical and microscopic investigation. With the microscope one or more of the following things were found in each sample: cayenne, starch, wheat, buckwheat, cocoanut shells, charred matter, sawdust and chaff.

In noting the character of the adulterants, we name in most cases the seed or the article from which the adulterant was derived. It is not always possible to state positively the particular product used. For example: where wheat starch and wheat tissue were identified, we have given wheat as the adulterant without attempting to say whether wheat middlings, wheat flour or wheat bran was used. The buckwheat products used were in some cases largely the black hulls, in others almost entirely the inner seed envelopes with starchy matter.

Whenever cocoanut shells and charred matter were both detected in the same sample, it is probable that the latter was derived from the former, although it was not always possible to identify the cocoanut "stone cells" in the blackened opaque masses.

Generally it is not possible to determine the exact per cent. of adulteration. In some samples, however, there was no evidence that any real pepper was present and the per cent. of ether extract showed that a number of samples did not contain more than 50 per cent. and in two cases not more than 20 per cent. of pure pepper. This does not disclose the full extent of adulteration, as most of the adulterants yield a considerable amount of ether extract.

In the columns giving the results of the chemical analyses, those figures which are abnormal, that is to say below 6.50% for ether extract, or above 16% for fiber, and 6.50% for ash, are printed in heavy faced type.

Table XII.—Adulterated Black Pepper.

Station No.	Brand (taken from label on package in which goods were sold).	Dealer.	Price paid per ½ pound. Cents.	Microscopic Examination—Adulterants detected.	Chemical Examination. Water.	Ether Extract.	Fiber.	Ash.
	Ground Pepper in labeled packages.							
5572	First Quality Black Pepper	W. K. Spencer, 96 Main St., Middletown	8	Farinaceous Matter	8.72	4.99	15.97	6.43
5575	Strictly Pure Black Pepper. Stocker & Brill, Newburgh, N. Y.	—— 79 White St., Danbury	10	Buckwheat, Wheat, Cocoanut Shells	10.54	5.33	19.43	8.63
5578	Pepper. E. B. Worthington, Norwich, Conn.	A. L. Allen, Norwich	10	Buckwheat, Wheat	8.50	4.45	21.14	4.42
5584	XX Pepper. The Challenge Mills, New York	A. J. Hopkins, Boston Branch, Norwich	10	Buckwheat, Cocoanut Shells, Charrod matter, Cayenne	8.96	5.45	26.63	4.02
5594	Pure pepper. E. S. Kibbe & Co., Hartford	S. E. Amidon, Willimantic	10	Buckwheat, Wheat, Cocoanut Shells, Charred matter, Cayenne	8.70	4.59	18.34	3.93
5601	A. & P. Pepper. Sultana Spice Mills	Atlantic and Pacific Tea Co., 269 East Main St., Bridgeport	15	Buckwheat, Wheat, Cocoanut Shells, Charred matter	9.92	4.94	14.06	3.91
5602	Windmill Brand Black Pepper. Loudon & Johnson, 181 Chambers St., New York	Ernest Glaeser, Rockville	8	Wheat, Sawdust, Cocoanut Shells, Charred matter	9.46	4.16	21.67	7.60
	Ground Pepper in bulk.							
5069		Keating's Store, cor. Oak and York Sts., New Haven	9	Wheat, Cayenne	10.49	3.27	13.72	6.71
5106		D. Dore, 377 Grand Ave., New Haven	5	Wheat	11.00	5.24	16.80	8.19
5450		B. Fowler, 6 High St., Hartford	10	Buckwheat, Wheat, Cocoanut Shells, Charred matter, Cayenne	8.09	6.32*	22.38	4.17
5487		Geo. A. Ferris, 184 Main St., Norwalk	7	Buckwheat, Cayenne	9.64	7.90†	15.88	5.54
5503		N. Y. Cash Grocery, 206 Main street, Stamford	7	Wheat, Grain Hulls, Cocoanut Shells, Charred matter, Cayenne	8.61	3.63	22.67	12.31
5505		N. Y. Grocery Co., 15 N. Main St., S. Norwalk	8	Wheat, Grain Hulls, Cocoanut Shells, Charred matter, Cayenne	8.01	3.68	23.01	12.18

* 1.35% Nitrogen in Ether Extract. † 1.88% Nitrogen in Ether Extract.

TABLE XII.—ADULTERATED BLACK PEPPER—*Continued.*

Station No.	Brand (taken from label on package in which goods were sold).	Dealer.	Price paid per ¼ pound. Cents.	Microscopic Examination—Adulterants detected.	Chemical Examination. Water.	Ether Extract.	Fiber.	Ash.
	Gronnd Pepper in bulk.							
5514	.....	F. W. Tracey, Preston	10	Wheat, Grain Hulls, Cocoanut Shells, Charred matter	9.55	3.09	17.06	3.71
5517	.....	Kinney's, Bank St, New Milford	10	Wheat (cracker crumbs), Cayenne	10.03	4.41	14.69	5.65
5519	.....	Wm. W. Blakeman, Derby Junction	8	Wheat, Cocoanut Shells, Charred matter, Cayenne	9.45	5.12	23.62	4.48
5523	.....	—— 191 East Main St., Bridgeport	10	Buckwheat, Wheat, Cocoanut Shells, Charred matter	9.67	5.24	23.64	3.81
5526	.....	D. Hallett, 470 E. Main St., Bridgeport	8	Buckwheat Hulls, Cayenne	10.41	2.09	27.04	7.37
5531	.....	Mrs. J. McGovern, 122 N. Washington Ave., Bridgeport	8	Buckwheat Hulls, Cayenne	10.96	1.40	27.71	7.81
5534	.....	A. J. Hopkins, Boston Branch, Norwich	10	Buckwheat. Cocoanut Shells, Charred matter, Cayenne	8.46	5.51	23.81	6.05
5537	.....	—— 87 White St., Danbury	7	Wheat (cracker crumbs), Cayenne	9.98	4.36	11.29	6.13
5541	.....	C. A. Allison, 31 Main St., Middletown	10	Wheat, Grain Hulls, Cocoanut Shells, Charred matter	9.60	2.71	15.24	3.95
5544	.....	Joseph Connor & Sons, Norwich	10	Buckwheat, Cocoanut Shells, Charred matter, Cayenne	7.74	4.08	27.59	5.35
5546	.....	J. B. Sullivan, cor. E. Main and Steuben Sts., Bridgeport	10	Buckwheat Hulls, Cayenne	10.96	1.38	26.42	8.83
5548	.....	Sam'l Z. D. Durand, 183 Main street, Birmingham	10	Wheat	10.04	5.74	15.85	6.80
5550	.....	Morris Sheild, 142 Main St., Birmingham	5	Wheat, Cocoanut Shells, Charred matter, Cayenne	8.49	5.38	25.01	4.05
5555	.....	Foote Bros., W. Main St., Waterbury	10	Wheat, Cocoanut Shells, Charred matter, Cayenne	8.34	3.52	18.96	4.22
5556	.....	E. A. Fitch, 64 Broadway, Norwich	10	Wheat, Cocoanut Shells, Chaffy matter, Cayenne	9.41	3.05	20.01	3.42
5565*	.....	A. L. Allen, Norwich	10	Buckwheat, Wheat	12.01	6.35	7.97	4.56

* 1.35% Nitrogen in Ether Extract.

In eight samples the percentage of all three constituents was beyond the standard limits. The same was true in 14 cases of two constituents and in five cases of one constituent.

Only one sample, No. 5487, was not condemned by any of these three determinations, but the ether extract from this showed no crystals of piperine and contained but 1.88% of nitrogen.

Two samples of buckwheat middlings analyzed at this Station (see Report for 1886, p. 111 and for 1888, p. 152) contained 7.55% and 8.06% respectively, of ether extract. A pepper may have the normal percentage of extract and yet be grossly adulterated with this product. Fortunately we have other means for detecting the admixture with certainty.

Black Pepper Suspected of Adulteration.—In Table XIII are included four samples of this class from packages bearing the name of the manufacturer or dealer, and eight sold in bulk.

No foreign matters were detected in these samples by the microscope, but chemical analysis indicates either the addition of pepper shells, or that the samples were ground from uncleaned peppercorns.

An analysis of a sample of "pepper shells" offered to the "trade" at one and three-quarter cents per pound in 25 ton lots, is given below, together with an analysis of long pepper.

	Station No.	Water.	Ether Extract.	Fiber.	Total Ash.	Sand.
Pepper shells or dust	5630	8.36	6.98	22.88	9.19	2.28
Long pepper, ground at the Station	5634	9.87	7.24	7.38	8.10	.55

TABLE XIII.—BLACK PEPPER SUSPECTED OF ADULTERATION.

Station No.	How sold.	Price per ¼ pound. Cents.	Chemical Examination.				
			Water.	Ether Extract.	Fiber.	Ash. (Total.)	Sand.
5589	In labeled package	10	8.54	8.18	**16.63**	**6.61**	1.75
5587	" " "	10	10.73	**6.48**	**17.62**	**6.67**	1.00
5580	" " "	10	11.73	6.77	15.66	**7.30**	1.43
5579	" " "	8	10.91	7.96	15.17	**6.95**	1.35
5561	In bulk	8	10.21	8.16	**16.97**	**7.85**	1.91
5535	" "	10	10.51	7.34	**18.87**	**6.90**	1.05
5525	" "	7	10.54	6.96	**20.29**	**6.56**	.88
5533	" "	8	10.48	**5.14**	**20.27**	**6.83**	1.04
5554	" "	10	10.42	7.43	14.01	**6.82**	1.70
5543	" "	10	10.07	7.85	12.32	**7.15**	1.80
5515	" "	6	11.32	9.41	14.09	**6.56**	1.35
5527	" "	10	10.21	7.59	12.56	**7.08**	2.10

White Pepper, Pure and Adulterated.—In Table XIV are given analyses of seven samples of white pepper, two of which are adulterated.

To recapitulate: 102 samples of pepper have been examined.

64	samples were probably pure pepper.
12	samples were suspected of adulteration.
31	samples were certainly adulterated.
107	

About 66 per cent. of the samples in packages were pure, about 52 per cent. of samples sold in bulk were pure.

TABLE XIV.—WHITE PEPPER, PURE AND ADULTERATED.

Station No.	Brand.	Dealer.	Price paid per ½ pound. Cents.	Microscopic Examination.	Chemical Examination.			
				Adulterants detected.	Water.	Ether Extract.	Fiber.	Ash.
	Peppercorns ground at the Station.							
5633	Singapore White Pepper			Pure	11.88	7.07	3.65	.99
5632	Siam White Pepper			Pure	11.73	6.80	4.16	1.69
	Ground Pepper in labeled boxes.							
5766	White Pepper. Absolutely Pure. D. & L. Slade & Co., Boston			Pure	12.31	*6.58	3.32	1.70
5586	Pure White Pepper. Packed expressly for Hills & Co., Hartford	Hills & Co., 368 Asylum St., Hartford	10	Pure	10.93	7.45	4.13	1.93
5582	White Pepper. Strictly Pure. Stocker & Brill, Newburgh, N. Y.	—— 79 White St., Danbury	10	Wheat	12.57	[illegible]	2.27	.68
	Ground Pepper in bulk.							
5545		Murray & Dorsey, 4 Truman St., New London	9	Pure	11.90	6.98	3.74	3.14
5542		Waterbury Cheap Grocery, 171 S. Main St., Waterbury	6	Buckwheat, Cayenne	9.40	†7.14	3.64	5.57

* 3.25 per cent. nitrogen in ether extract.

† 0.59 per cent. in ether extract.

MUSTARD.

BY A. L. WINTON.

A portion of the chemical work described in this paper was done by Mr. W. L. Mitchell.

The genuine mustard of commerce is made chiefly, if not wholly, from the seeds of the black mustard (*Brassica nigra*), and white mustard (*Brassica alba*).

Cabbage, cauliflower, turnip and other well known plants belong to the same genus, *Brassica*, and their seeds are like those of the mustards in form and structure.

Black mustard seed is about as large as dust shot, and varies in color from light brown to black. When rubbed up with water there is formed the volatile oil of mustard, which has a penetrating and highly pungent odor as well as taste.

White mustard seed is several times as large as seed of the black species, has a buff color, and when pulverized and moistened emits no odor of mustard oil, but has a sharp, acrid taste.

The pure ground mustard of commerce consists of the ground seed of one, or of a mixture of both the black and white species, the husks being separated by bolting. Oftentimes a portion of the fatty oil of the seed is extracted, as the pungency is not thereby affected and the mustard meal is said to keep better.

Adulterations of Mustard.—The common adulterants of mustard are make-weights : such as starchy matters (wheat flour, etc.) and plaster or terra alba—and coloring matters: such as turmeric and Martius' yellow.

The use of flour in mustard has been defended on the ground that pure mustard does not keep well and is too pungent for ordinary use.

To color mustard, turmeric is generally used. It is prepared from the root of a plant allied to ginger, and its bright yellow color and spicy taste make it sought after for the purpose.

The use of Martius' yellow is objectionable, as it is distinctly poisonous.

These dyes hide the presence of white adulterants and have a brilliant yellow color. The natural color of pure ground and hulled mustard seeds is, however, a very pale yellow.

Examination of Samples of Mustard from the Connecticut Market.

Methods.—Ash or mineral matter was determined by direct incineration.

Turmeric was detected by its characteristic color reaction with ammonia. The method given in Allen's Commercial Organic Analysis, Vol. III, Part 1, p. 154, was followed in testing for Martius' yellow.

Starch was detected by microscopic examination.

Pure Uncolored Mustard.—In Table XV are included 15 samples of this kind. These samples were not only free from starchy and mineral adulterants, but contained no coloring matter foreign to the mustard seed. They were without exception of a dull yellow color and contrasted strongly with the vivid yellow of mustards dyed with turmeric or Martius' yellow. The per cent. of ash ranged from 4.20 to 7.82.

Mustard Artificially Colored.—Table XVI includes 24 samples of this class in which no foreign matter, except coloring, was detected. Martius' yellow was present in four samples, turmeric in the remaining 20 samples.

Mustard Adulterated or "Compounded" with Starchy Matter or Gypsum.—There are grouped under this head in Table XVII "mustards," 30 in number, in which either flour or plaster was present in considerable quantity. Three of these, Nos. 5665, 5666 and 5672, were conspicuously labeled mustard on the broader sides of the boxes, and on one of the narrower sides it was stated, in much smaller type and in the words given in the table, that the article is a compound.

Of the 30 samples examined, 26 contained considerable quantities of wheat flour or other starchy matter and four were adulterated with gypsum or terra alba. Twenty-four were colored with turmeric, four with Martius' yellow and two appeared to be colored, although no dye was identified. Eleven were in labeled boxes, the remainder sold in bulk.

The quantity of lime present was determined in the four samples adulterated with gypsum and the equivalent sulphate of lime (anhydrous) ranged from 12.97 to 15.34 per cent., but the actual percentage of adulterant present was probably greater, owing to combined water.

Table XV.—Pure Uncolored Mustard.

Station No.	Brand.	Dealer.	Price paid per ¼ pound. Cents.	Ash.
	In labeled packages.			
5775	Oxford Mustard, Absolutely Pure, D. & L. Slade Co., Boston	Lorenzo Dibble, N. Main St., S. Norwalk	10	6.28
	In bulk.			
5664		W. S. Chappell, 148 State St., New London	13	4.73
5691		P. T. Gloster & Co., Winsted	10	5.94
5694		T. Kilmartin, 495 W. Main St., Waterbury	13	6.51
5074		Keating's Store, Cor. York & Oak Sts., New Haven	9	5.62
5659		Keeney Bros., Rockville	10	7.79
5073		Henry Hahn, 1327 W. Chapel St., New Haven	9	5.57
5075		F. H. Kearney, Cor. Congress Ave. and Hill St., New Haven	10	7.78
5640		Beckwith & Keefe, 125 Bank St., New London	10	6.20
5646		J. E. St. John, Bank St., New London	10	6.63
5682		Village Store Co., East Main St., Bridgeport	6	5.60
5681		McGraw & Baldwin, White St., Danbury	12	5.93
5677		James Sullivan, Putnam	10	4.20
5675		P. M. LeClair, Putnam	10	6.48
5647		W. H. Brown, Moosup	10	7.82

TABLE XVI.—MUSTARD ARTIFICIALLY COLORED—OTHERWISE PURE.

Station No.	Brand.	Dealer.	Price paid per ¼ pound. Cents.	Ash.	Color.
	In labeled packages.				
5645	Pure Durham Mustard, Howard & Co. Guaranteed absolutely pure	T. W. Potter, 72 State St., New London	10	6.00	Martius' yellow.
5638	Pure Mustard, Boardman & Sons, Hartford	J. Kerin, 62 North St., New Britain	15	5.89	Turmeric.
5650	Strictly Pure Mustard, L. Battey & Son, Moosup	L. Battey & Son, Moosup	10	6.27	"
5654	Pure Mustard, J. H. Beard, Full Weight	Shelton Cash Store, J. H. Beard, Prop., 476 Howe Ave., Shelton	9	4.73	"
5669	Mansfield's Pure Mustard, W. H. Mansfield & Co, Putnam	Mansfield & Co., Putnam	10	7.11	"
5670	Gauntlet Brand Mustard, E. R. Durkee & Co., New York	G. A. Ray, Norwich	10	5.30	"
5680	Pure Mustard, Union Spice Co.	Union Pacific Tea Co., 253 Main St., Danbury	10	5.60	"
5700	Mustard, O. H. Blanchard, All goods bearing my trade mark strictly pure	Joseph Copland, Cor. North and Clark St., New Britain	10	5.73	"
5643	Pure Mustard, Warranted strictly pure, Bennett, Sloan & Co., New York	Wm. S. O'Brien, New London	10	4.19	"
5652	Mustard, Grand Union Tea Co., New York	Grand Union Tea Co., 237 Main St., Birmingham	10	6.58	"
	In bulk.				
5653		Dillon's Cash Grocery Store, 158 Main St., Ansonia	7	5.42	"
5657		Morris Sheild, 142 Main St., Birmingham	5	4.98	"
5688		D. W. Lawton, Main St., Winsted	12	6.29	"
5686		Stevens' Cash Grocery, 398 E. Main St., Bridgeport	8	5.94	"
5679		Barnum & Reed, 307 Main St., Danbury	12	5.52	"
5678		John P. Murphy, Norwich	10	5.46	"
5662		F. W. Tracy, Preston	10	5.76	"
5648		W. N. Arnold, Danielson	10	7.15	"
5649		Perkins & Bliss, Willimantic	10	7.11	"
5656		Sam'l Z. D. Durand, 183 Main St., Birmingham	10	7.44	"
5703		A. D. Cook, 56 Market St., Hartford	8	5.85	"
5660		Purinton & Reade, Willimantic	12	6.19	Martius' yellow.
5690		——— 793 Bank St., Waterbury	10	5.84	"
5701		Boston Branch Grocery, 238 Main St., New Britain	10	6.20	"

Table XVII.—Mustard Adulterated or "Compounded" with Starchy Matter or Plaster.

Station No.	Brand.	Dealer.	Price paid per ¼ pound Cents.	Ash.	Coloring.	Adulterants detected.
5685	A. & P. Mustard, Sultana Spice Mills	Atlantic & Pacific Tea Co., 269 E. Main St., Bridgeport	15	3.96	Turmeric.	Starchy matter.
5639	Celebrated English Mustard, Cole & Firth, London	Murray & Dorsey, 4 Truman St., New London	10	9.14	"	" "
5692	Crescent Mills Pure Mustard, Warranted Pure, John P. Augur, New Haven	Foote & Westwood, W. Main St., Waterbury	15	3.98	"	" "
5651	Mustard, Lincoln, Seyms & Co., Hartford. All goods bearing our signature are strictly pure and warranted	E. F. Platt, 37 E. Main St., Waterbury	15	20.08*	"	Sulphate of lime or plaster.
5693	London Mustard, Warranted extra strong	Johnson's Cash Grocery, Main St., Winsted	12	3.32	"	Starchy matter.
5683	Selected Mustard	Kinney's, Bank St., New Milford	10	3.44	"	" "
5671	Pure Mustard, Alert Mills, New York	W. H. Cardwell, Norwich	15	10.62†	"	Lime and starchy matter.
5674	Pure Mustard, Packed for Hills & Co., Hartford	Hills & Co., 368 Asylum St., Hartford	10	17.68‡	"	Sulphate of lime or plaster.
5665	Colman's Mustard, Mfd. in England, warranted to be the finest mustard compound	Frank Larrabee, Willimantic	15	3.94	?	Starchy matter.
5672	Keene's Mustard, London. This is an admixture in which no injurious ingredients are used	W. H. Cardwell, Norwich	17	3.49	?	" "
5666	Colburn's A Mustard. The A. Colburn & Co. Philadelphia. The finest compound for table or medicinal use	A. A. Trudeau, Willimantic	12	4.17	Turmeric.	" "
5705		F. H. Lewis, 98 W. Main St., Meriden	10	4.06	"	" "
5702		Jacob Walz, 54 Temple St., Hartford	10	3.55	"	" "
5699		Jos. Copland, Cor. North & Clark Sts., New Britain	10	4.18	"	" "
5698		C. A. Allison, 31 Main St. Middletown	10	4.24	"	" "
5695		Foote Bros., W. Main St., Waterbury	10	4.93	"	" "
5689		King & Gay, Main St., Winsted	12	2.20	"	" "
5687		Wilcox & Adams, Main St., Winsted	10	3.99	"	" "
5641		W. A. Murray, 672 Bank St., New London	10	2.42	"	" "
5676		Joseph Connor & Sons, Norwich	10	2.93	"	" "
5661		E. A. Fitch, 64 Broadway, Norwich	15	3.79	"	" "
5658		H. W. Steele & Co., Main St., Birmingham	9	3.98	"	" "
5655		Wm. W. Blakeman, Derby	10	5.75	"	" "
5642		S. D. Amico & Co., 64 Main St., New London	10	4.61	"	" "
5673		Morse Mills Store, Putnam	10	4.87	"	" "
5684		W. S. Cornwall, 173 E. Main St., Bridgeport	10	4.31	Martius' yellow.	" "
5696		Thos. Walsh, 486 Main St, Middletown	8	4.49	"	" "
5704		M. Ahern, 160 Pratt St., Meriden	10	4.04	"	" "
5697		J. B. Patterson, 110 Main St., Middletown	10	19.64§	Turmeric.	Sulphate of lime or plaster.
5072		Henry S. Dailey, 97 Whalley Ave., New Haven	10	21.10‖	"	" " "

* Of which 6.18 per cent. calcium oxide, equivalent to 15.03 per cent. calcium sulphate. † Of which 4.41 per cent. calcium oxide (not as sulphate).
‡ Of which 6.10 per cent. calcium oxide, equivalent to 14.83 per cent. calcium sulphate. § Of which 6.30 per cent. calcium oxide, equivalent to 15.34 per cent. calcium sulphate. ‖ Of which 5.34 per cent. calcium oxide, equivalent to 12.97 per cent. calcium sulphate.

CHEESE.

BY A. L. WINTON.

Seventy-two samples of cheese have been examined with special reference to the possible presence of oleo-oil, which is said to be extensively used as a "filler." "Filled cheese" is made from an emulsion of oleo-oil and skim-milk.

In none of the samples was the presence of oleo or other foreign fats discovered.

Method of Examination. Volatile fatty acids were determined in the fat obtained from the cheese by grinding with anhydrous copper sulphate and extracting with ether, as directed for the determination of fat in cheese by Short's method.*

If desired, the percentage of fat and the volatile acids in the fat may be determined in one weighed portion, thus ascertaining whether the cheese was made from whole or skim milk, and whether or not it has been "filled." As there is no restriction on the sale of skim milk cheese in Connecticut, the percentage of fat was disregarded.

In order to have sufficient material for two extractions, 20 grams of cheese and 40 grams of anhydrous copper sulphate were ground to a powder. It was found necessary to perform this operation soon after receiving the samples, as cheese open to the air soon dries and becomes hard and horny; and on the other hand, if kept in a closed jar it moulds. The ground mixture of cheese and copper salt, however, keeps indefinitely, and the subsequent processes may be carried out whenever convenient.

The extract (corresponding to 10 grams of cheese) was collected in a tared flask so that after removal of the ether the weight of the extract could be taken. If more than 2.5 grams were obtained, a portion was removed. In the cases of skim milk cheeses the extract weighed less than 2.5 grams, but was sufficient for the determination of volatile fatty acids, being in all cases more than 1 gram.

The Leffmann & Beam modification of the Reichert process was employed,† using half quantities of reagents to correspond with the half quantity of fat taken. The saponification was carried out in the flasks used for the extraction.

The names and addresses of the dealers from whom samples were obtained are given in the following list. The prices paid ranged from 10 to 18 cents per pound.

Ansonia, W. H. Bronson, 234 Main St.; York State Butter Store, 176 Main St.

* U. S. Dept. Agr. Div. Chem. Bull. 43, 371.

† Analyst, 1891, XVI, 153.

Birmingham, H. W. Steele & Co., 99 Main St.; D. M. Welch & Co., Main St.

Bridgeport, Geo. A. Robertson, 70 State St.; New York Butter House, 12 Fairfield Ave.

Colchester, W. S. Curtis, Broadway.

Collinsville, N. Bachand.

Danbury, York State Butter House, Main St., Danbury; Butter Store, 43 White St.

Danielson, A. H. Armington, Railroad Sq.; Waldo Bros., Main St.; W. N. Arnold, Main St.

Hartford, W. W. Walker, 269 Main St.; John A. Pilgard, 138 Front St.; M. J. Feeley, 26 Front St.

Manchester, Fitch & Drake.

Meriden, D. C. Huggins & Co., 31 E. Main St.; Russell Bros., N. Y. Butter and Grocery Store; E. O. Chapman, 64 E. Main St.

Middletown, B. Carbo, Rapello Ave.; Gardner, 121 Main St.

Naugatuck, C. N. Todd's Cash and Exchange Store; Dillon's Cash Grocery Store.

New Britain, Boston Branch Grocery, 238 Main St.; Vermont Butter Store, Main St.; Wm. Cowlishan, 420 Main St.

New Haven, John Franklin, 71 Nash St.; M. C. Dingwall, 66 Congress Ave.; McGovern Bros., 1037 State St.; Broadway Butter Store, 153 Broadway; A. Duhan, 1134 State St.; New Haven Butter Store, 116 Congress Ave.; D. M. Welch & Son, Congress Ave.; D. Dore, 579 Grand Ave.; Butter Store, 391 Grand Ave.; C. T. Downes & Son, 1 Broadway.

New London, Thos. W. Gardner, State St.; M. Pick, 6 Main St.; Chappell, 148 State St.; J. E. St. John, Bank St.

Norwalk, The New York Grocery, Main St.; W. R. Bates, Main St.

Norwich, Bailey & Connell, 40 Broadway; C. W. Hill, Franklin St.; Appley & Jordan, 88 W. Main St.; Somers Bros., 224 Main St.

Plainfield, Walter Tillinghast, Main St.; Kingsley's Store.

Putnam, Brainard & Bartlett, 72 Main St.; W. H. Mansfield & Co.

Rockville, L. Young; Union St. Grocery, 30 Union St.

S. Norwalk, Lorenzo Dibble, N. Main St.

Stonington, James Pendleton, Water St.

Thompsonville, Henry King.

Torrington, The Torrington Coöperative Co., 47 Main St.; Philip Aperion, S. Main St.; G. S. Weeks, 184 Main St.

Wallingford, M. N. Brainerd; F. H. Smith; W. Murray.

Warehouse Point, Aaron Smith.

Waterbury, Brownell, Boston Butter House, 147 S. Main St.; Branch of York State Butter Co., 844 Bank St.; L. P. & A. M. Guilfoile, 777 Bank St.

Willimantic, H. C. Hall, 17 Union St.; Bert Thompson, 798 Main St.; Holden Arnold, 999 Main St.

Windsor Locks, Ed. Coogan.

EXAMINATION OF COFFEE.

By A. L. Winton.

Coffee is the seed of a small tree whose fleshy fruit is about the size of a small cherry and contains two seeds joined on their flat sides, which when freed from the pulp and the enveloping membrane are the coffee "beans" of commerce.

The money value of coffee annually imported into this country exceeds that of any other single import, except possibly sugar.

During the year ending June 30, 1895, 532,938,473 pounds were imported, having a wholesale value (at a little over 16 cents per pound) of $87,372,901.61. The imports of ground chicory during the same year amounted to 9,544,186 pounds, and were valued (1.7 cents per pound) at $158,142. In addition to the above, 463,579 pounds of unground chicory and 2,807,360 pounds of dandelion root and other coffee substitutes came into the country.

Adulterants of Coffee.

Among the materials which, either dried or roasted, have been used to mix with and adulterate pure coffee are the following: roots of chicory, dandelion, beets and carrots; wheat, rye, barley and other grains; peas, beans and other leguminous seeds; acorns; figs; imitation coffee, sometimes moulded into artificial beans, sometimes in masses, granules, etc.

Examination of Samples Purchased in Connecticut.

One hundred and twenty-four samples collected by the Station agents have been examined. These may be classified as pure and adulterated ground coffee, coffee substitutes and compound coffees. All were in the roasted state.

Methods of Examination.

By careful sorting, the adulterants in whole coffee were readily separated and in some cases the percentage of adulteration was determined. Microscopic examination of the foreign material was necessary in order to positively determine its nature.

Fragments of foreign material may usually be recognized without the aid of a lens and picked out from adulterated coffee after it has been ground to the usual degree of fineness. This preliminary examination is greatly facilitated by separating the finer from the coarser material by means of a sieve.

Another easy method of separation is to shake a portion of the sample with cold water. The particles of coffee for the most part float, whereas the common adulterants sink.

Material of suspicious character, separated by either of the methods just named, was examined microscopically to fully determine its nature.

Fragments which, from their sweet taste and the color imparted to water were believed to be chicory, were usually found under the microscope to have the pitted ducts and other characteristic tissues of chicory. No attempt was made to distinguish between chicory and the other roots which often are used as an adulterant of, or substitute for, chicory. The term "chicory," as used in this paper, refers to what is known in the trade under that name.

In order to identify the various leguminous seeds, the size and form of the palisade and "supporting" cells of the hull were observed either in sections or, more conveniently in my experience, in portions which had been heated on a slide for a short time with dilute potash and gently crushed with a cover glass. By this latter method, after a few preliminary tests to get potash solution of the proper concentration and to heat for the proper length of time, cells of both layers were easily isolated without being seriously altered in size and form. The palisade cells when thus detached rested on their sides, and with proper care many of the "supporting" cells were in the same position so that it could be seen whether they were prismatic (as in the bean) or spool-shaped, as in most other legumes.

It was difficult and sometimes impossible to distinguish fragments of wheat kernels from rye, either by the shape of the fragments, size of starch granules or cell structure, because these characters had been obscured or wholly destroyed by roasting.

It was not always possible to determine the kind of starch present in the imitation coffee, described on page 54, because the granules were often distorted as if they had been heated. The presence of vegetable hairs and fragments of tissue, however, aided identification.

Unground Coffee.

Although the larger part of the coffee on sale in this State is in the bean, still only a few purchases of the unground coffee were made since in many of the stores visited by the Station's agents the coffee was found on inspection to be of undoubted purity.

Pure unground coffee.—Two samples of genuine coffee beans were purchased in labeled packages as follows:

5987. Union Club Coffee, Lincoln, Seyms & Co., Hartford. Bought of A. Wilson, Norwich, 38 cents per pound.

6006. Winslow, Rand & Watson's Red Label Java and Mocha Coffee. Bought of Carten Tea Co., Bridgeport.

The remainder of the samples of genuine coffee beans were bought of the following dealers, the price ranging from 25 to 38 cents per pound:

The Original India Tea Co., *Bridgeport.* N. Bachand, Chas. McAleer, Frank Perri, *Danbury.* Waldo Bros., *Danielson.* M. J. Feeley, Mrs. Kramer, *Hartford.* Bissell & Brough, *Manchester.* Lane & Peters, *Milford.* Unite L. Frank Tea Co., Frank E. Hull, Store 1152 State St., New England Tea Co., H. Frank & Son, *New Haven.* Thomas & Gumble, Store junction Bank and Truman Sts., Corkey & Gannon, Keefe & Davis, M. Winslow Dart, *New London.* Brainard & Bartlett, *Putnam.* L. Young, *Rockville.* D. S. Davenport, Brown & Wilcox, *S. Norwalk.* Moses Pendleton, *Stonington.* J. F. O'Hear, M. Mitchell, *Thompsonville.* W. Murray, *Wallingford.* Aaron Smith, *Warehouse Point.* The N. Y. and China Tea Co., *Waterbury.* S. E. Amidon, Bert Thompson, *Willimantic.*

Adulterated unground coffee.—Eleven samples were purchased, and the results of their examination are given in Table XVIII. The adulterants detected were chicory, crushed and roasted peas and lumps of "imitation coffee."

By the term imitation coffee we refer to certain masses of brown, starchy material sometimes found in adulterated coffee. These are made chiefly of wheat flour or middlings mixed sometimes with pea hulls or pea meal. This mixture, in form of a paste, is apparently moulded in sticks or cylinders about half an inch in diameter, which after drying can be crushed or ground with the coffee.

Imitation coffee, moulded in form of coffee beans, instead of sticks, has not been found in any samples which we have examined.

In general, the presence of the adulterants which we have encountered in whole coffee would hardly escape the notice of the careful observer, if he had opportunity to glance at the mixture before it was ground, an opportunity which, in the experience of our sampling agents, is not always accorded to him.

Ground Coffee.

Pure Ground Coffee.—In Table XIX are given five brands of pure ground coffee which were sold in sealed and labeled packages.

Only two samples of pure ground coffee sold in bulk were found on sale. These were purchased of James Pendleton, Water St., Stonington (34 cts. per pound), and Chappell's Store, 148 State St., New London (38 cts. per pound).

TABLE XVIII.—ADULTERATED WHOLE OR BROKEN COFFEE, SOLD IN BULK.

Station No.	Dealer.	Adulterants Detected.	Price per Pound. (Cents.)
5973	F. W. Miner, Wallingford	‡Peas, chicory	25
6011	C. T. Downes & Son, 1 Broadway, New Haven	‡Peas, chicory	25
6004	A. Duhan, Cedar Hill Cash Grocery, 1134 State St., New Haven	26% peas, 19% chicory	25
6009	*M. C. Dingwall, 66 Congress Ave., New Haven	Chicory, "imitation coffee"	20
6003	John Franklin, 71 Nash St., New Haven	42% chicory and "imitation coffee"	25
5983	R. A. Nichols, 60 Courtland St., Bridgeport	‡Peas, chicory, "imitation coffee"	25
5997	F. M. Miller, 38 W. Main St., Meriden	23% peas, 45% chicory and "imitation coffee"	25
5994	Geo. W. Gates, Main St., Windsor Locks	24% peas, 31% chicory and "imitation coffee"	25
5989	†Doran's Cash Grocery, 150 Main St., Danbury	14% peas, 21% chicory and "imitation coffee"	24
6002	New Haven Provision Co., 398 Grand Ave., New Haven	12% peas, 22% chicory and "imitation coffee"	25
5979	Walter Tillinghast, Plainfield	‡"Imitation coffee"	25

* Coffee sold for Coffee Screenings. Was almost as fine as ground coffee. † Sold for "crushed Java."

‡ Ground by dealer, hence the percentage of adulteration could not be readily determined.

TABLE XIX.—PURE GROUND COFFEE, SOLD IN LABELED PACKAGES.

Station No.	Brand.	Dealer.	Price per Pound. Cents.
5972	Café Royal Coffee, Benedict & Thomas, New York	Gilbert & Thompson, New Haven	45
5958	Seal Brand Java and Mocha Coffee, Chase & Sanborn, Boston (powdered)	James' Cash Grocery, Danielson	38
5959	Seal Brand Java and Mocha Coffee, Chase & Sanborn, Boston (ground)	The Torrington Coöperative Co., 47 Main St., Torrington	40
5957	Union Club Coffee, Lincoln, Seyms & Co., Hartford	W. D. Mead, Collinsville	35
5948	High Life Java and Mocha Coffee, Winslow, Rand & Watson	H. C. Hall, 17 Union St., Willimantic	38

Adulterated Ground Coffee.—Fifty-eight out of sixty-four samples sold as "ground coffee" were found to be adulterated.

Of these, five were sold in labeled packages, giving the name of grinder, or wholesaler, without any statement to indicate that they were mixtures of coffee with other materials.

These were the following:—

5964. Sealed package labeled: "The American Java Coffee (W. G. & B.) Company." "Office of the American Java Coffee Co., 233, 235 and 237 Washington St., New York," etc. Bought of Lorenzo Dibble, South Norwalk. Price 22 cents per pound package. A gilt band cup and saucer given away with a pound.

Contains *chicory and peas.*

5965. Sealed package labeled: "Genuine Mocha Coffee, John P. Augur, Crescent Mills, New Haven." Bought of Adam Wagner, Ashmun St., New Haven. Price 25 cents per pound package.

Contains *chicory and peas.*

6050. Sealed package labeled: "Welcome Coffee gives uniform satisfaction. Manufactured only by Bryan, Miner & Read, New Haven, Conn. The buyer of this coffee receives free with each package 1 bar of Welcome soap. One pound fresh ground." Bought of Geo. W. Gates, Windsor Locks. Price 25 cents per package.

Contains *chicory and peas.*

5960. Sealed package labeled: "Boardman & Sons' Celebrated Excelsior Coffee, 304 Asylum St., Hartford." Bought of R. Fowler, Ford St., Hartford. Price 15 cents per pound package.

Contains *chicory, peas and "pellets."*

6015. Labeled on package from which sample was taken and on bag into which it was put: "Old Style Java, S. H. Brownell & Co., 26 to 31 Canal St., Providence, R. I." Bought (for coffee and chicory) of James' Cash Grocery, Danielson. Price 25 cents per pound.

Contains *imitation coffee.*

The detailed descriptions of the other adulterated samples, sold in bulk, fifty-three in number, are given in Table XX.

The foreign materials detected were chicory, roasted peas, wheat and rye, "imitation coffee" (such as has been described on page 54) and an adulterant consisting of pea hulls made into little granules with bran or middlings. These, for convenience, we have designated as "pellets."

Coffee Compounds.

Under this head are grouped eleven mixtures which, as regards their composition and appearance, are like the adulterated ground coffees, but since they were sold in packages with statements on the labels (often, however, in very small type and obscurely placed) as to their character, they are separately considered.

6018. "Columbus Coffee, Chris. Columbus Coffee Company, 245 and 249 Washington St., New York. The contents of this package is a mixture or a Compound of Choice Roasted Coffee, Cereals and Chicory, Blended in such proportions as to produce a good beverage." Bought for coffee of Chas. Brenker, Torrington. Price 22 cents per pound package.

Contains *coffee, peas* and *chicory.*

5963. "Palmer's Compound Dandelion Coffee, Palmer's Dandelion Coffee Company, Norwich." Bought of C. W. Hill, Norwich. Dealer stated it was a compound. Price 20 cents per pound.

Contains *coffee, peas, chicory,* possibly other ingredients.

6051. "Red Star Blended Java. A blend of choicest Padang Java with roasted cereals," etc. Bought for coffee of the Torrington Coöperative Company. Price 25 cents per pound.

Contains *coffee, peas* and *chicory.*

TABLE XX.—ADULTERATED GROUND COFFEE, SOLD IN BULK.

Station No.	Dealer.	Adulterants detected.	Price per pound. Cents.
5901	C. N. Todd's Cash and Exchange Store, Naugatuck	Chicory, Peas	25
5902	Dillon's Cash Store, Naugatuck	" "	25
5903	Healy's South End Groceries, 622 S. Main St., Waterbury	" "	25
5913	Ransom Bros., 17 Market St., Rockville	" "	24
5920	W. H. Bronson, 234 Main St., Ansonia	" "	25
5923	Ed. Coogan, Windsor Locks	" "	25
5925	M. N. Brainerd, Wallingford	" "	25
5926	Willis L. Pond, Torrington	" "	20
5927	The Union Pacific Tea Co., 204 Main St., Ansonia	" "	25
5928	Samuel Z. D. Durand, 193 Main St., Birmingham	" "	25
5938	John P. Murphy, W. Main St., Norwich	" "	25
5945	Adam Wagner, Ashmun St., New Haven	" "	25
5951	Grand Union Tea Co., 88 State St., New London	" "	25
5953	Thos. W. Gardner, State St., New London	" "	20
5969	Geo. E. Cleaveland, 200 State St., Bridgeport	" "	25
5974	O. Coledezky, 68 Morgan St., Hartford	" "	25
5947	B. Carbo, Rapallo Ave, Middletown	Chicory, Wheat or Rye	24
5968	New England Tea Co., 442 Main St, Middletown	Chicory, "Imitation Coffee"	25
5907	Branch of York State Butter Co., 844 Bank St., Waterbury	" " "	25
5908	L. P. & A. M. Guilfoile, 777 Bank St., Waterbury	" " "	25
5910	Logan Bros., 863 Main St., Bridgeport	" " "	25
5911	John Driscoll, Cor. Main and High Sts., Bridgeport	" " "	25
5924	Henry King, Thompsonville	" " "	20
5967	The New York Grocery Co., Main St., Norwalk	" " "	25
5931	F. H. Smith, Wallingford	" " "	25
5905	Jas. F. Phelan, 41 E. Main St., Waterbury	Chicory, "Pellets"	25
5906	Moore's Cash Grocery, 804 Bank St., Waterbury	" "	28

TABLE XX.—ADULTERATED GROUND COFFEE, SOLD IN BULK.—*Continued.*

Station No.	Dealer.	Adulterants detected.	Price per pound. Cents.
5914	Village Store Co., Cor. State and Broad Sts., Bridgeport	Chicory, "Pellets"	25
6068	The Great Atlantic and Pacific Tea Co., 29 E. Main St., Waterbury	" "	25
5970	J. McEwen, 117 Saltonstall Ave., New Haven	Chicory, Peas, "Imitation Coffee," Pellets	25
5912	Union Street Grocery, 30 Union St., Rockville	" " " " "	25
5921	Grant's Tea and Coffee Store, Cor. State and Main Sts., Meriden	" " " " "	25
5944	McGovern Bros., 1037 State St., New Haven	" " " " "	25
5909	Chas. W. Starr, New Milford	Chicory, Peas, "Imitation Coffee," "Pellets," Wheat or Rye	25
5916	The Union Pacific Tea Co, cor. Main and Golden Hill Sts., Bridgeport	Chicory, Peas, "Imitation Coffee"	25
5922	James Keevers, Main St., Windsor Locks	" " " "	25
5930	York State Butter Store, 176 Main St., Ansonia	" " " "	25
5932	Holden Arnold, 999 Main St., Willimantic	" " " "	25
5935	H. A. Wheaton, Spring St., Danielson*	" " " "	25
5937	A. H. Armington, Railroad Square, Danielson	" " " "	28
5954	Gardner's Store, Elm St., Stonington	" " " "	20
5929	H. A. Willard, 268 Main St., Ansonia	Chicory, Peas, Wheat or Rye	25
5943	W. G. Graves, 341 Grand Ave, New Haven	" " " "	25
5946	Daniel Dore, 579 Grand Ave., New Haven	" " " "	12
5949	S. E. Amidon, 877 Main St., Willimantic	" " " "	25
5950	Hong Kong Tea Co., 210 Main St., Norwich	" " " "	35
5917	G. S. Weeks, 184 Main St., Torrington	"Pellets," Wheat or Rye	25
5904	American Tea Co., Wright & Weible, 42 E. Main St., Waterbury	"Pellets," "Imitation Coffee"	25
5918	B. Moffitt, 373 Main St., New Britain	"Imitation Coffee"	30
5934	Edward Mullan, 25 Main St., Putnam	" "	25
5962	Brainard & Bartlett, 72 Main St., Putnam	" "	25
5915	C. A. Wills, 364 Fairfield Ave., Bridgeport	Chicory	25
5919	Barry's New York Store, 374 Main St, Ansonia	"	25

* Sold for mixture of Java and Mocha screenings.

6007. "Eclipse blended crushed Coffee. In compounding this coffee we have selected goods that will give a much stronger and richer flavor than many of the so called pure coffees. A compound roasted and packed on the day shipped. Eclipse Coffee Co., 61 Hudson Street, New York." Bought for coffee of W. R. Bates, Norwalk. Price 23 cents per pound in a quart fruit jar. It was unground.

It contains 40 per cent. *coffee beans* whole or broken.
20 " *crushed peas.*
40 " *imitation coffee* and *chicory* (not separated).

6016. "Arabian Ground Coffee, full weight. 130 Franklin St., New York. This package contains ground coffee." The word "compound" was on another part of the package. Bought of T. W. Potter, New London. Price 15 cents per pound.

Contains *coffee, chicory* and *peas.*

5956. "Old reliable Java Coffee Company, New York." The following statement was printed in small type, "made of pea berry coffee and chicory." Bought of C. H. Bailey, 34 Enterprise St., Colchester. Price 25 cents per pound. A cup and saucer given away with each pound.

Contains *chicory*, *peas* and *cereals.*

5971. "Excelsior French Breakfast Coffee Compound. From Dwinell, Wright & Co., Boston, Mass." Bought for coffee of J. E. Sullivan, Putnam. Price 10 cents per pound.

Contains *chicory*, *peas*, *cereals;* coffee was not detected.

5961. "Hayward & Co., French Breakfast Coffee Compound. Dwinell, Wright & Co., Boston." This was put up in the same kind of package as No. **5971** with a similar label. Bought of W. W. Walker, 269 Main St., Hartford, for coffee. Price 8 cents per pound.

Contains *chicory*, *peas*, *cereals;* coffee was not detected.

6049. "Enterprise Compound Breakfast Coffee, Lincoln, Seyms & Co., Hartford." Bought for coffee of Ed. Coogan, Windsor Locks. Price 25 cents per pound.

Contains *coffee, chicory* and *peas.*

6080, 6019. "*Old Grist Mill Entire Wheat Coffee*, Potter & Wrightington, Boston, Mass." A sealed package of this article was sent to this station with the request that it be examined for real coffee, which it was claimed not to contain.

It was stated on the label: "Is a perfect hygienic product of the Entire Wheat Kernel. It is not ground from the coffee berry,

and while possessing all the delicate flavor of Java or Mocha it contains none of their injurious qualities."

Another package of the Old Grist Mill Entire Wheat Coffee was bought by a station agent of N. A. Fullerton, New Haven, for 20 cents, a loaf of entire wheat bread being given away with it. The label was in all respects the same as the first with two exceptions. First, in place of the above quotation the following was substituted :

"Is a perfect hygienic product containing the entire wheat kernel, roasted and ground. It has all the delicate flavor of Java and Mocha; but, unlike these coffees, it does not produce biliousness or irritate the nerves."

Second. The statement was added, "It is in every sense a Pure Health Food."

Both packages contained *some coffee, mixed with wheat and with a considerable quantity of ground peas.*

Coffee Substitutes.

The following preparations from roasted cereals, etc., contain no real coffee and no such claim is made for them :

6017. "Ayers Hygienic Substitute for Coffee, M. S. Ayer, Boston." Bought of Sliver's Grocery, Stonington. Price 20 cents per pound.

6014. "New Era Improved Hygienic Coffee, E. C. Rich Co., New York and Boston." Bought of W. W. Walker, Hartford. Price 20 cents per pound.

5966. "Shredded Cereal Coffee, The Cereal Machine Co., Boston." Bought of H. C. Hall, Willimantic. Price 20 cents per pound.

6013. "J. W. Clark's Phosphi Cereal Nervine Coffee, a wholesome and nutritious substitute for the coffee bean, tea and chocolate. Clark & Alden, N. Woburn, Mass." Bought of Boston Branch Grocery, New Britain. 20 cents per pound.

RECAPITULATION.

The 122 samples which have been examined may be classified as follows :

UNGROUND COFFEE.

	In labeled packages.	In bulk.	Total.
Pure	2	31	**33**
Adulterated	0	11	**11**

GROUND COFFEE.

	In labeled packages.	In bulk.	Total.
Pure	5	2	**7**
Adulterated	5	53	**58**
Coffee Compounds	11	0	**11**
Coffee Substitutes (no real coffee)	4	0	**4**
Total			**124**

It appears that most of the unground coffee on sale is pure, although 11 *samples were purchased which were found to contain one or more of the following adulterants in quantities ranging from* 12 *to* 42 *per cent.: crushed peas, imitation coffee (moulded from starchy materials) and chicory.*

89 *per cent. of the ground coffee found on sale was grossly adulterated. The adulterants detected were peas, "imitation coffee," "pellets" (pea hulls and starchy matter made into granules) wheat, rye and chicory. Only two samples of pure ground coffee sold in bulk were found on sale.*

MILK.

By E. H. Jenkins and A. L. Winton.

During the month of May one hundred and five samples of milk were bought by agents of the Station from grocers and a few bakeries in all parts of the city of New Haven.

The analyses of these samples show the general quality of the milk sold by grocers, which is quite likely to be rather poorer than that delivered by milkmen to families.

The per cents. of total solids in these samples were as follows:

Over	13		per cent. solids,	16 samples.
Between	12	and 13	per cent. solids,	51 samples.
Between	11.5	and 12.0	per cent. solids,	19 samples.
Between	11.0	and 11.5	per cent. solids,	12 samples.
Between	10.5	and 11.0	per cent. solids,	6 samples.
Under	10.5		per cent.	1 sample.
Total				105

The per cents. of fat found were:

Over	5.0		per cent. fat,	3 samples.
Between	4.5	and 5.0	per cent. fat,	2 samples.
Between	4.0	and 4.5	per cent. fat,	36 samples.
Between	3.5	and 4.0	per cent. fat,	37 samples.
Between	3.0	and 3.5	per cent. fat,	17 samples.
Between	2.5	and 3.0	per cent. fat,	10 samples.
Total				105

The following twelve samples judged by the commonly received standards are adulterated:

No.	Dealer.	Specific Gravity.	Solids.	Fat.	Solids not fat.
7728	Mrs. P. E. Davis, 228 Shelton Ave.	29.2*	11.35	3.14	8.21
7749	M. Maremma, 76 Oak St.	30.7	11.03	2.80	8.23
7769	Cor. Washington and Portsea Sts.	20.6	10.00	3.72	6.28
7773	185 Columbus Ave. cor. Liberty St.	28.7	11.39	3.50	7.89
7783	Cor. Lawrence, opposite Forsyth's Dye Works	30.4	11.45	3.20	8.25
7787	Ferry St., cor. Pierpont St.	31.0	10.38	2.29	8.09
7799	398 Grand Ave.	28.4	11.43	3.60	7.83
7800	D. Dore, Grand Ave	30.5	11.48	3.20	8.28
7817	Stier's Bakery, 127 Congress Ave.	28.5	11.09	3.30	7.79
7821	Mrs. P. E. Davis, 228 Shelton Ave.	30.3	10.92	2.60	8.32
7827	N. Stein, 815 Grand Ave.	29.0	10.55	2.89	7.66
7828	Bakery, cor. State and Olive Sts.	29.5	10.59	2.60	7.99

* Read 1.0292.

Eleven samples beside these, whether adulterated or not, were of such inferior quality as not to be fairly marketable.

Twenty-three samples of milk, therefore, or more than one-fifth of the whole number examined, were either adulterated, or of such inferior quality that their sale might justly be prohibited by statute or city ordinance.

It is a perfectly familiar fact that pure milk from healthy cows has no fixed and constant composition.

Differences of breed, individual differences among cows of one breed, the age of the cows, the feed, and the period of lactation, all affect the chemical composition of the milk in a very marked degree.

The differences in chemical composition of pure milk are, however, very much smaller when comparison is made between the mixed milk of many cows rather than between the milk of individual cows.

Milk which is sold in our cities represents, almost without exception, the mixed milk of a number of cows or of herds.

State and municipal governments, boards of health and associations of official chemists have from time to time adopted "standards" of composition of milk, fixing minimum percentages of solids, fat, and solids not fat, or a specific gravity which shall serve to distinguish pure or marketable milk from adulterated or unmarketable milk.

Thus, in the State of New York, a seller is liable to prosecution if the milk has less than 12 per cent. of solids and 3 per cent. of fat.

In Massachusetts, milk must contain 13 per cent. of solids in all months except May and June, and in those months must have at least 12 per cent. of solids.

The standard adopted by the Society of Public Analysts of England is

Solids	11.50
Fat	3.00
Solids, not fat	8.50

The standard which is fair for one country or section or State is not necessarily fair for another.

If the standard is a reasonable one it will sometimes happen that pure, unadulterated milk of very inferior quality will fall below its requirements and thus be condemned as adulterated when it is not.

But the public ought to be protected from genuine milk of a very poor quality as well as from richer milk which has been adulterated.

We believe that in this State milk which is sold at the usual market rates ought to have a specific gravity between 1.029 and 1.033, with not less than 3.5 per cent. of fat and 11.50 per cent. of solids; and if any two of the three fall below the minimum named, the milk should be declared unsalable.

We consider these as the lowest limits which should be recognized in this State and leave the question open for the present whether they are not too low.

It would seem to be wise to forbid the sale, under penalty, of any milk which does not come up to the prescribed quality, leaving the question of wilful adulteration out of the issue.

All of the samples of milk examined were tested for preservatives, but none were found in any of them.

The use of preservatives in milk without notice to the purchaser is clearly forbidden in the sixth provision of section 3 of the pure food law.

CREAM OF TARTAR.

BY A. W. OGDEN.

Cream of tartar is made from argol, an incrustation formed during the fermentation of wines, and is brought into commerce as a white crystalline solid or powder having a pleasant, sour taste.

It is, chemically considered, acid potassium tartrate, which when chemically pure contains 25.0 per cent. of potash.

"It usually contains from 2 to 7 per cent. of calcium tartrate, an amount admissible in samples for medical use, but it sometimes contains from 8 to 13 per cent. of tartrate of calcium."—(*U. S. Dispensatory*, *15th Ed.*, *1153.*)

It is used in cookery to "raise" bread by setting free carbonic acid from the salæratus or "soda" which is mixed with dough.

One hundred and three samples bought by the Station agents for cream of tartar have been examined.

Thirty-five were in packages bearing the manufacturer's, grinder's or packer's name and brand. Of these, seven were adulterated, as will be seen in Table XXI.

The samples bearing the names of the following firms were unadulterated: Austin, Nichols & Co., N. Y., Berry Wisner, Lohman & Co., N. Y., Bugbee and Brownell, Providence, R. I., Clark, Chapin & Bushnell, N. Y., Francis H. Leggett & Co., N. Y., Lincoln, Seyms & Co., Hartford, Ct., James P. Powers & Co., N. Y., James Pyle, N. Y., D. & L. Slade Co., Boston, Mass., Stickney & Poor, Boston, Mass., Thurber, N. Y.

Sixty-eight samples of cream of tartar were bought in bulk from retail grocers in different parts of the State.

Twenty-four of these were variously adulterated, some of them containing no cream of tartar at all.

Partial analyses of them, with statement of the adulterants, are given in Table XXI.

In addition to the adulterants named in the table, all of the samples, with exception of Nos. 537, 539, 557, 665 and 1500, also contained starch.

TABLE XXI.—ADULTERATED CREAM OF TARTAR.

No.	Manufacturer or Wholesaler.	Retailer.	Analysis.						Nature of Adulteration.
			Potash.	Soda.	Lime.	Sulphuric Acid.	Phosphoric Acid.	Nitrogen.	
543	Sold in bulk.	H. Glover & Son, Wall St., Norwalk	.19	3.59	20.37	8.96	38.94	....	Acid phosphate of lime.
644	"	Philip Aperion, 8 Main St., Torrington	trace.	2.48	25.06	12.96	33.01	.10	" " "
572	"	M. Blanchette, 263 So. Main St., Waterbury	....	2.36	21.84	13.24	32.18	.12	" " "
1439	"	Appley & Jordan, 88 West Main St., Norwich	.85	2.10	24.28	21.63	23.74	....	" " "
574	"	Healey's South End Groceries, 622 So. Main St., Waterbury	....	1.84	20.04	23.87	23.67	.44	" " "
1434	"	A. Wilson, 78 Franklin St., Norwich	trace.	2.91	23.68	20.42	22.20	....	" " "
649	"	York State Butter Store, 176 Main St., Ansonia	....	1.38	16.94	21.54	21.98	.50	" " "
700	Coburn & Co. First Quality.	W. G. Graves, 341 Grand Ave., New Haven	1.23	1.50	19.78	25.95	15.94	.52	" " "
544	Sold in bulk.	———, 53 Main St., Norwalk	.22	2.20	29.80	32.05	15.46	....	" " "
1450	"	H. A. Wheaton, Spring St, Danielson	.21	1.30	13.50	12.91	13.75	....	" " "
622	Challenge Mills, N.Y.	J. A. Pillgard, 138 Front St., Hartford	....	....	....	....	....	....	" " "
527	" " "	C. H. Reid, 476 Main St., Bridgeport	7.33	1.55	18.22	14.88	18.45	.09	" " "
632	Sold in bulk.	R. Fowler, Ford St., Hartford	15.07	1.67	7.50	10.34	1.66	....	Sulphate and phosphate of lime.
1458	"	Kingsley's Store, Plainfield	14.87	1.15	10.20	8.79	9.56	....	" " " "
1431	"	E. A. Fitch, Broadway, Norwich	14.20	1.63	10.34	9.14	10.00	....	" " " "
593	"	D. M. Welch & Son, Congress Ave., New Haven	12.23	1.61	12.72	19.43	....	.18	Plaster.
659	"	" " " Main St., Derby	11.59	1.43	10.92	18.48	....	.18	"
658	"	Barry's New York Store, 374 Main St., Ansonia	10.95	1.42	12.60	19.98	....	.20	"
539	"	Gustav E. Friedrich, South Norwalk	9.70	1.25	17.88	24.90	....	....	"
557	Bennett, Sloan & Co.	M. McPhelan, White St., Danbury	8.22	1.33	18.46	27.13	....	.20	"
1500	" " "	J. McEwen, 117 Saltonstall Ave., Fair Haven	....	....	....	....	....	....	"
1476	Sold in bulk.	S. C. Amidon, 877 Main St., Willimantic	6.83	1.69	8.74	21 27	6.56	1.08	Sulphate and phosphate of lime.
1427	"	Keefe and Davis, 125 Bank St., New London	4.51	2.37	17.94	13.02	13.78	....	" " " "
637	Crescent Mills, New Haven.	G. S. Weeks, 184 Main St., Torrington	4.46	1.50	15.38	23.12	12.51	.60	" " " "
1497	Crescent Mills, New Haven.	New Haven Provision Co., 398 Grand Ave., Fair Haven	....	....	....	....	....	....	" " " "
554	Sold in bulk.	Mastin & Co., 79 White St., Danbury	....	1.85	27.42	38.80	...	....	Plaster.
548	"	New York Grocery Co., Main St, Norwalk	1.16	1.29	26.04	36.34	....	trace.	"
665	"	Morris Sheild, Main St., Derby	2.01	1.48	26.00	39.14	....	.30	"
610	"	Geo. W. Gates, Main St., Windsor Locks	.17	1.27	30.94	39.34	9.40	....	Sulphate and phosphate of lime.
611	"	James Keevers, Main St., Windsor Locks	.23	5.22	31.30	38.63	10.76	....	" " " "
537	"	A. Malmo's Market, Main St., So. Norwalk	....	1.84	27.74	38.69	9.43	trace.	" " " "

CEREAL FOODS.

BY A. L. WINTON.

Nine samples have been examined. No corn starch or tissue was found in any of them.

No wheat was found in the oat meals. All appeared to be properly branded and unadulterated.

The brands examined were the following:—

Oat Preparations.

H. O., made by Hornby's Oatmeal Co., New York.

Quaker Rolled White Oats, made by the American Cereal Co., Chicago, Ill.

Street's Perfection Rolled White Oats, and Toasted White Oats, made by S. H. Street & Co., New Haven, Ct.

Wheat Preparations.

Fould's Wheat Germ Meal, made by Fould's Milling Co., Cincinnati.

Wheatlet, made by Franklin Mills Co., Lockport, N. Y.

Eli Pettijohn's Best, made by Eli Pettijohn Cereal Co., Minneapolis.

Pettijohn's Breakfast Gem, C. S. Lanmeister.

Ralston Health Club Breakfast Food, made by Robinson-Danforth Co., St. Louis, Mo.

Street's Perfection Wheatine, made by S. H. Street & Co., New Haven.

Wheatena.

SUMMARY.

As appears in the following table, this report contains the results of examination of 849 articles of food of thirteen different kinds.

With the exception of Martius' yellow, found in minute quantity in certain samples of mustard, no poisonous adulterants have been found.

Table XXII.

	Examined.	Pure.	Doubtful.	Adulterated.
Maple Syrup	61	48	5	8
" Sugar	7	7	--	--
Sugar	16	16	--	--
Syrup	4	4	--	--
Strained Honey	48	43	--	5
Comb "	12	12	--	--
Lard	118	75	--	43
Pepper	102	62	8	32
Mustard	69	15	--	54
Cheese	72	72	--	--
Coffee	124	53	--	69
Milk	105	82	11	12
Cream of Tartar	103	72	--	31
Cereal Foods	9	9	--	--
	848	570	24	254

Of the whole number examined

67.2 per cent. were pure.

2.9 " were doubtful.

29.9 " were adulterated within the meaning of the act.

STATE LAWS REGARDING ADULTERATION OF FOOD AND DRUGS.

The following laws regarding special forms of adulteration of food or drugs are now on the statute books of this State and, with the Pure Food Law already printed on page 2, give a complete view of our legislation on this subject.

The statute regulating the sale of imitation butter created the office of Dairy Commissioner, who is charged with the execution of the laws regarding the sale of butter, molasses and vinegar. Numerous prosecutions have been brought for violation of these laws.

No one is charged with the execution of the laws regarding Adulteration of Milk, Adulteration of Candy, Adulteration of Spirituous and Intoxicating Liquors, and Adulteration of Drugs and Medicines. Boards of Health are *permitted* to act under the statute regarding the Adulteration of Food, but we cannot learn that any action was ever brought under any of these statutes, which do not make it the duty of some official or institution to see to their enforcement.

ADULTERATION OF BUTTER.

[G. S. 1888, Ch. CLVI.]

[Amended by Ch. CXIV, Public Acts, Jan. Sess. 1893, and Ch. XXXII, Public Acts, Sess. 1895.]

SEC. 2614. Any article resembling butter in appearance and not made wholly, salt and coloring excepted, from the milk of cows, shall be imitation butter within the meaning of this chapter. The words "butter," "dairy," or "creamery" shall form neither the whole nor a part of the name of any imitation butter, or appear upon any article, or upon any box, tub, or package containing imitation butter.

SEC. 2615. No person by himself, or his agents, or servants, shall render or manufacture, sell, offer for sale, expose for sale, take orders for the future delivery of, or have in his possession with intent to sell, any article, product or compound made wholly or partly out of any fat, oil or oleaginous substance or compound thereof, not produced from unadulterated milk or

cream from the same, which shall be in imitation of yellow butter produced from pure unadulterated milk or cream of the same; provided that nothing in this act shall be construed to prohibit the manufacture or sale of oleomargarine in a separate and distinct form and in such manner as will advise the consumer of its real character free from coloration or any ingredient that causes it to look like butter. No imitation butter shall be sold or exposed for sale or delivered except under the following conditions: First, the seller shall maintain in plain sight, over or next the main outer entrance of the premises where the selling is done, a sign bearing in plain, black roman letters, not less than two inches wide and four inches long, on a white ground, the words "sold here," preceded by the name of the imitation article. If the selling is done from a wagon, or other vehicle, such vehicle shall conspicuously bear upon its outside, on both sides of said wagon or vehicle, such a sign. If the delivering is done from a wagon or other vehicle, such vehicle shall conspicuously bear, upon its outside, on both sides of said wagon or vehicle, a sign bearing in plain, black, roman letters, not less than two inches wide and four inches long, on a white ground, the words "delivered here," preceded by the name of the imitation article. Second, all imitation butter shall be kept in an enclosing package which shall bear on the outside of its body, and also of its cover, at all times in plain sight of a beholder of the package, in black, roman letters, not less than one inch wide, and two inches long, on a white or light-colored ground, the name of the imitation article.

Third, the seller shall orally inform each buyer at each sale that the article he buys is not butter, and shall give the buyer the name of the imitation article.

Fourth, every person, copartnership, or corporation, selling, or offering for sale, any imitation butter, and every keeper of a hotel boarding-house, or restaurant, temporary or permanent, who shall furnish any guest with any imitation butter, or food containing it, shall within fifteen days after the passage of this act, or within fifteen days after commencing said business, and annually on the first day of May, or within fifteen days thereafter, register in a book kept by the Dairy Commissioner for that purpose, the name and the town, street and number of street of the place of business of said person, copartnership, corporation, keeper of hotel, boarding-house, or restaurant. All signs prescribed in sections

2615, 2616 and 2617 of the General Statutes, shall be provided by the Dairy Commissioner, and all signs required, under provisions of section 2515 of the General Statutes, to be maintained in plain sight, over or next the main outer entrance of the premises where the selling is done, shall be placed in position, under the direction of the Dairy Commissioner or his deputy. All signs so furnished by the Dairy Commissioner shall be paid for by the parties receiving the same, the same to be furnished at the actual cost thereof.

SEC. 2616. No baker or vender of food shall sell or expose for sale any article of food containing imitation butter unless such baker or vender shall maintain the same kind of a sign as hereinbefore first prescribed, in the way and manner prescribed in that connection, except that the word "used" shall be substituted for the word "sold." If the selling be done from a wagon, or other vehicle, such vehicle shall conspicuously bear such a sign.

SEC. 2617. No keeper of a hotel, boarding-house, or restaurant, temporary or permanent, shall furnish any guest with any imitation butter, or food containing it, unless such keeper shall maintain in plain sight of all guests sitting at tables where food is served such a sign or signs as hereinbefore prescribed, except that the word "used" shall be substituted for the word "sold."

SEC. 2618. The Governor shall appoint a citizen of the State as a Dairy Commissioner, who shall hold office for two years from and after the first day of May succeeding his appointment, and until his successor is appointed, unless sooner removed by the Governor for cause; and in case of his death, resignation, or removal, the Governor shall fill the vacancy. It shall be the duty of the Dairy Commissioner to attend to the enforcement of this chapter throughout the State. A room in the Capitol shall be set apart for the Dairy Commissioner. He may appoint and remove a deputy, who may also act as clerk. The Dairy Commissioner and his deputy shall have free access, at all reasonable hours, for the purpose of examining into any suspected violation of this chapter, to all places and premises, apartments of private families keeping no boarders excepted, where the Dairy Commissioner or his deputy suspects imitation butter to be made, sold, or used; and on tender of the market price of good butter for the same may take from any person, firm, or corporation, samples of any articles suspected to be imitation butter. The Dairy Commissioner may have samples suspected to be imitation butter

analyzed at the Connecticut Experiment Station, or by any State chemist, and a sworn or affirmed certificate of the analyst shall be *prima facie* evidence of the ingredients and constituents of the sample analyzed. Any one refusing the Dairy Commissioner, or his deputy, access, in a reasonable manner and at a reasonable time, to premises for said purpose of examination, or refusing to sell samples as hereinbefore provided for, shall incur the penalty hereinafter first provided for violation of this chapter.

The Dairy Commissioner shall make an annual report to the Governor, and such annual reports shall be submitted to the General Assembly at its regular session.

SEC. 2619. Any person violating any of the provisions of sections 2614, 2615 or 2616, and any person except a boarding-house keeper violating section 2617, shall for the first offence be fined not more than one hundred dollars, or imprisoned not more than sixty days, or both; for any subsequent offence said fine and imprisonment shall be doubled. Any boarding-house keeper violating section 2617 shall for the first offence be fined twenty-five dollars, or imprisoned not exceeding thirty days, or both; for any subsequent offence, said fine and imprisonment last mentioned shall be doubled. Evidence of any violation of this chapter, shall be *prima facie* evidence of wilful violation, with knowledge.

ADULTERATION OF MILK.

[G. S. 1888, Ch. CLVIII.]

SEC. 2658. Whoever shall knowingly sell, supply, or bring to be manufactured to any butter or cheese manufactory in this State any milk diluted with water, or adulterated by the addition of any foreign substance, or from which any milk or cream or milk commonly known as strippings has been taken; or whoever shall knowingly bring or supply milk to any butter or cheese manufactory that is tainted or partly sour, shall forfeit not less than twenty-five nor more than one hundred dollars, with costs of suit, for the benefit of the person or persons upon whom such fraud shall be committed.

SEC. 2659. The usual test for quality and the certificate of analysis of the Director of the Connecticut Agricultural Experiment Station shall be deemed *prima facie* proof of adulteration.

SEC. 2660. No person shall sell, offer or expose for sale any milk from which the cream, or any part thereof, has been removed, without distinctly and durably affixing a label, tag, or mark of metal in a conspicuous place upon the outside, and not more than six inches from the top of every can, vessel, or package containing such milk, and such metal label, tag, or mark shall have the words "Skimmed Milk" stamped, printed, or indented thereon in letters not less than one inch in height; and such milk shall only be sold or retailed out of a can, vessel, or package so marked.

SEC. 2661. No person shall sell or offer for sale, or shall have in possession with intent to sell or offer for sale, any impure or adulterated milk.

SEC. 2662. Every person who shall violate any of the provisions of the two preceding sections shall be fined not more than seven dollars, or imprisoned not more than thirty days, or both.

SEC. 2663. A printed notice of this and the five preceding sections shall be conspicuously posted in all public places, creameries or factories where milk is received or sold.

SEC. 2664. Any person who shall knowingly sell, or expose for sale, milk, or any product of milk, from any cow which shall have been adjudged, by the Commissioners upon Diseases of Domestic Animals, affected with tuberculosis, or other blood disease, shall be fined not more than seven dollars, or imprisoned not more than thirty days, or both.

ADULTERATION OF MOLASSES.

[G. S. 1888, Ch. CLVII.]

[Amended by Ch. CCXXXVIII, Public Acts, Jan. Sess., 1889.]

SEC. 2620. It shall be the duty of the Dairy Commissioner to attend to the enforcement of the law against the adulteration of molasses and the sale of adulterated molasses, and for the purpose of examining into suspected violations of such law, he shall, at all reasonable hours, have free access to all places and premises where he suspects that molasses is adulterated or adulterated molasses is sold, and, on tender of the market price of good molasses for the same, he may take from any person, firm or corporation, samples of molasses which he suspects is adulterated;

and he may have samples of molasses suspected to be adulterated analyzed by any State chemist or by the Experiment Station, and a sworn or affirmed certificate of such analyst shall be *prima facie* evidence of the ingredients and constituents of the sample analyzed; and if such analysis shall show that the molasses is adulterated, he shall make complaint to the proper prosecuting officer that the person or persons who adulterated said molasses, or sold or exposed for sale such adulterated molasses, may be prosecuted.

SEC. 2621. Any person refusing the Dairy Commissioner or his deputy access in a reasonable manner and at a reasonable time for said purpose of examination, or refusing to sell samples as hereinbefore provided, shall be fined not more than seven dollars, or imprisoned not more than thirty days, or both.

SEC. 2622. Any person who shall adulterate any molasses, or who shall sell, or offer, or expose for sale, or who shall solicit or receive any order for the sale or delivery within this State, or for delivery without this State for shipment into this State, of any molasses adulterated with salts of tin, terra alba, glucose, dextrose, starch sugar, corn syrup, or other preparation of or from starch, shall be fined not more than five hundred dollars, or imprisoned not more than one year, or both. The delivery of any of the above mentioned preparations upon any order solicited or received within this State, shall be conclusive evidence that the order, upon which such delivery was made, was for such articles, and shall render the person soliciting or receiving such order liable to the penalty above prescribed.

ADULTERATION OF CANDY.

[Chapter CLXXXIII, Acts of Session of 1895.]

Be it enacted by the Senate and House of Representatives in General Assembly convened:

Any person who shall adulterate candy with terra alba, barytes, talc, or any other mineral substance, or with poisonous colors or flavors, or knowingly sell or offer for sale candy so adulterated, shall be punished by a fine of not more than one hundred dollars.

AN ACT TO PREVENT FRAUD IN THE MANUFACTURE AND SALE OF VINEGAR.

[Chap. LX, Acts of Session of 1889, as amended by Chap. CCXXXIV of Acts of same Session.]

Be it enacted by the Senate and House of Representatives in General Assembly convened:

SECTION 1. No person shall make and sell, or make for sale, as cider vinegar, any vinegar not produced wholly from the juice of apples. No person shall add to any vinegar, or to any article sold or to be sold as vinegar, any drug, any hurtful or foreign substance, any coloring matter, or any acid, other than acetic. Any person violating this section of this act shall be fined fifty dollars for a first offense, and for a second or later offense he shall be fined one hundred dollars and imprisoned thirty days.

SEC. 2. No person shall make and sell, or make for sale, any vinegar not having an acetic acidity equivalent to the presence therein of not less than four per centum by weight of absolute acetic acid, and in the case of cider vinegar, not less than two per centum by weight of cider vinegar solids upon full evaporation over boiling water. No maker of vinegar shall sell the same without conspicuously branding, stenciling or painting upon the head of the barrel, cask, keg, or package containing the same, the name of the maker, his residence or place of manufacture, and in the case of cider vinegar, the words "cider vinegar," *provided* that this clause concerning marking shall not apply to retail sales, at the place of manufacture, in quantities of less than five gallons, and in open packages. Any person violating this section of this act shall be fined ten dollars for a first offense, and for a second or later offense fifty dollars.

SEC. 3. No person shall sell, or offer, or expose for sale, or exchange, or solicit, or receive any order for the sale or delivery within this State, or for delivery without this State for shipment into this State: first, any vinegar, as cider vinegar, not wholly produced from the juice of apples; or second, any vinegar, or article sold or to be sold as vinegar, in which has been added any drug, or any hurtful or foreign substance, or any coloring matter, or any acid other than acetic; or third, any vinegar not having an acetic acidity equivalent to the presence therein of not

less than four per centum by weight of absolute acetic acid, and in case of cider vinegar, not less than two per centum by weight of cider vinegar solids upon full evaporation over boiling water; or fourth, any vinegar made in this State and purchased by the person last mentioned of the maker in a barrel, cask, keg or other package not branded, stenciled or painted as required by a previous section of this act. Any person violating this section of this act shall be fined ten dollars for a first offense, and for a second or later offense fifty dollars. The delivery of any of the above mentioned articles upon any order solicited or received within this State shall be conclusive evidence that the order upon which such delivery was made was for such articles, and shall render the person soliciting or receiving such order liable to the penalty above prescribed.

SEC. 4. It shall be the duty of the Dairy Commissioner to attend to the enforcement of this act; and, for the purpose of examining into suspected violations thereof, he shall at all reasonable hours have free access to all places and premises where he suspects that any provision of this act is violated, and on tender of the market price of good vinegar therefor, he may take from any person, firm or corporation, samples of vinegar which he suspects of being made or sold in violation of this act; and he may himself analyze such samples, or have such samples analyzed by any State chemist or by the Experiment Station; and a sworn or affirmed certificate by such analyst shall be *prima facie* evidence of the ingredients and constituents of the sample analyzed; and if such analysis shall show that such sample does not conform to any requirement of this act, and shall give the Dairy Commissioner reasonable ground for belief that any provision of this act has been violated he shall make complaint to the proper prosecuting officer, to the end that the violator may be prosecuted.

SEC. 5. Any person refusing the Dairy Commissioner or his deputy access, in a reasonable manner and at a reasonable time, for said purpose of examination, or refusing to sell samples as hereinbefore provided, shall be fined not more than seven dollars, or imprisoned not more than thirty days, or both. Evidence of any violation of this act shall be *prima facie* evidence of wilful violation with knowledge.

ADULTERATION OF SPIRITUOUS AND INTOXICATING LIQUORS.

[G. S. 1888, Ch. CLXXXVII, Sec. 3100.]

Every person who shall manufacture, sell, or keep for sale, any spirituous or intoxicating liquors, or any liquors made or compounded in imitation thereof, which are adulterated with any deleterious or poisonous substance, shall be fined not more than two hundred and fifty dollars, which fine shall be paid, one-half to him who shall prosecute to effect, and the other half to the town in which such offense is committed.

ADULTERATION OF DRUGS AND MEDICINES.

[G. S. 1888, Ch. CLXXXVIII, Sec. 3129.]

Every person who shall knowingly adulterate or cause any foreign or inert substance to be mixed with any drug, or medicinal substance or preparation recognized by any pharmacopœa or employed in medical or medicinal practice, so as to weaken or destroy its medicinal effect, or shall sell such drug, or compound, knowing it to be so adulterated or mixed, shall be fined not less than ten, nor more than one hundred dollars, and upon conviction, all such adulterated or mixed articles in his possession may be seized upon a warrant issued by the court in which such conviction is had, and destroyed by the officer by whom such seizure shall be made.

ADULTERATION OF FOOD.

[G. S. 1888, Ch. CLVIII.]

SEC. 2648. The boards of health of the several cities, boroughs, and towns, in this State, may from time to time, at their discretion, procure from any dealer in provisions, groceries, medicines, or other articles of consumption, samples of such articles, and cause the same to be analyzed by one of the State chemists, and if on such analysis it shall be found that the article analyzed is adulterated with any deleterious or foreign ingredient or ingredients, other than is represented verbally and in a conspicuous

label by the seller, the chemist making the analysis shall issue his certificate setting forth the kind and quantity, as near as may be, of deleterious and foreign ingredients found in the article analyzed, and the board of health causing such analysis to be made shall cause said certificate to be published in some paper published in the city, borough, or town, or one nearest thereto, where the article analyzed was obtained, for such length of time as they may think proper, and the cost of analysis, together with the cost of the publication of the certificate, shall be paid by the person or firm from whom the article analyzed was obtained; and if such person or firm shall so elect, he or they may annex to said certificate his or their sworn affidavit, setting forth from whom the article analyzed was purchased by him or them.

SEC. 2649. In all cases where an analysis has been made according to the provisions of the preceding section, and the article or articles analyzed shall have been found pure and free from foreign ingredients, the cost of the analysis shall be paid by the city, borough, or town, whose board of health, or any officer thereof, caused such analysis to be made.

SEC. 2650. Every person who shall adulterate any sugar, or who shall knowingly sell, or offer or expose for sale any sugar which has been adulterated with salts of tin, terra alba, glucose, dextrose, starch sugar, corn syrup, or other preparation from starch, shall be fined not more than five hundred dollars, or imprisoned not more than one year.

COMMERCIAL FERTILIZERS.

During 1896 fifty-two manufacturing firms have entered for sale in this state two hundred and fifty-five distinct brands of fertilizers, viz:

Special manures for particular crops	91
Other nitrogenous superphosphates	104
Bone manures and "bone and potash"	33
Chemicals, including fish, tankage and castor pomace	27
	255

The duties of this Station regarding fertilizers are prescribed by law as follows:

THE FERTILIZER LAW OF CONNECTICUT.

The General Assembly, in 1882, passed an Act concerning Commercial Fertilizers, which, as amended in 1893, is now in force.

Attention is specially called to the following requirements of the law, the full text of which is printed on pages 83 and 84.

1. In case of *all* fertilizers or manures, except stable manure and the products of local manufactures of less value than ten dollars a ton, the law holds the SELLER responsible for *affixing a correct label or statement* to every package or lot sold or offered, as well as for the *payment of an analysis fee* of ten dollars for each fertilizing ingredient which the fertilizer contains or is claimed to contain, *unless* the MANUFACTURER OR IMPORTER has provided labels or statements and has paid the fee. Sections 4005 and 4007.

The Station understands "the fertilizing ingredients" to be those whose determination in an analysis is necessary for a valuation, and which are generally Nitrogen, Phosphoric Acid and Potash. The analysis fees in case of any fertilizer will therefore usually be ten, twenty or thirty dollars, according as one, two or three of these ingredients are contained or claimed to exist in the fertilizer.

2. The law also requires, *in the case of every commercial fertilizer*, that a *sealed sample* shall be deposited with the Director of the Station by the MANUFACTURER OR IMPORTER, and that a *certified statement* of composition, etc., shall be filed with him. Section 4006.

A statement of the per cent. of Nitrogen, Phosphoric Acid (P_2O_5) and Potash (K_2O), and of their several states or forms, will suffice in most cases. Other ingredients may be named if desired.

In all cases the per cent. of *nitrogen* must be stated. Ammonia may also be given when actually present in ammonia salts, and "ammonia equivalent to nitrogen" may likewise be stated.

The per cent. of soluble and reverted phosphoric acid may be given separately or together, and the term "available" may be used in addition to, but not instead of, soluble and reverted.

The percentage of insoluble phosphoric acid may be stated or omitted.

In case of Bone, Fish, Tankage, Dried Meat, Dried Blood, etc., the chemical composition may take account of the two ingredients: Nitrogen and Phosphoric Acid.

For Potash Salts give always the per cent. of Potash (potassium oxide): that of Sulphate of Potash or Muriate of Potash may also be stated.

The chemical composition of other fertilizers may be given as found in the Station Reports.

3. It is also provided that EVERY PERSON in the State, who sells *any commercial fertilizer of whatever kind or price*, shall annually report certain facts to the Director of the Experiment Station, and on demand of the latter shall deliver a sample for analysis. Section 4008.

4. All "CHEMICALS" that are applied to land, such as Muriate of Potash, Kainite, Sulphate of Potash and Magnesia, Sulphate of Ammonia, Nitrate of Potash, Nitrate of Soda, etc.—are considered to come under the law as "Commercial Fertilizers." Dealers in these chemicals must see that packages are suitably labeled. They must also report them to the Station, and see that the analysis fees are duly paid, in order that the Director may be able to discharge his duty as prescribed in Section 4013 of the Act.

It will be noticed that the State exacts no license tax either for making or dealing in fertilizers. For the safety of consumers and the benefit of honest manufacturers and dealers, the State requires that it be known what is offered for sale, and whether fertilizers are what they purport to be. With this object in view the law provides, in Section 4013, that all fertilizers be analyzed, and it requires the parties making or selling them to pay for these analyses in part; the State itself paying in part by maintaining the Experiment Station.

ACTS CONCERNING COMMERCIAL FERTILIZERS.

Chapter CCLIII of the General Statutes of Connecticut as amended by Chapter CLXXII of the Acts of the General Assembly, Session of 1893.

SECTION 4005. Every person or company who shall sell, offer, or expose for sale, in this State, any commercial fertilizer or manure except stable manure, and the products of local manufacturers of less value than ten dollars a ton, shall affix conspicuously to every package thereof a plainly printed statement clearly and truly certifying the number of net pounds of fertilizer in the package, the name, brand, or trade-mark under which the fertilizer is sold, the name and address of the manufacturer, the place of manufacture and the chemical composition of the fertilizer, expressed in the terms and manner approved and usually employed by the Connecticut Agricultural Experiment Station.

If any such fertilizer be sold in bulk, such printed statement shall accompany every lot and parcel sold, offered or exposed for sale.

SEC. 4006. Before any commercial fertilizer is sold, offered, or exposed for sale, the manufacturer, importer or person who causes it to be sold, or offered for sale, within this State shall file with the Director of the Connecticut Agricultural Experiment Station two certified copies of the statement prescribed in section 4005, and shall deposit with said director a sealed glass jar or bottle containing not less than one pound of the fertilizer, accompanied by an affidavit that it is a fair average sample thereof.

SEC. 4007. The manufacturer, importer, agent, or seller of any commercial fertilizer shall pay on or before May 1, annually, to the Director of the Connecticut Agricultural Experiment Station, an analysis fee of ten dollars for each of the fertilizing ingredients contained or claimed to exist in said fertilizer: *provided*, that when the manufacturer or importer shall have paid the fee herein required for any person acting as agent or seller for such manufacturer or importer, such agent or seller shall not be required to pay the fee prescribed in this section.

SEC. 4008. Every person in this State who sells, or acts as local agent for the sale of any commercial fertilizer of whatever kind or price, shall annually, or at the time of becoming such seller or agent, report to the Director of the Connecticut Agricultural Experiment Station his name and brand of said fertilizer,

with the name and address of the manufacturer, importer, or party from whom such fertilizer was obtained, and shall, on demand of the Director of the Connecticut Agricultural Experiment Station, deliver to said director a sample suitable for analysis of any such fertilizer or manure then and there sold or offered for sale by said seller or agent.

SEC. 4009. No person or party shall sell, offer, or expose for sale, in this State, any pulverized leather, raw, steamed, roasted, or in any form, as a fertilizer or as an ingredient of any fertilizer or manure, without explicit printed certificate of the fact, such certificate to be conspicuously affixed to every package of such fertilizer or manure, and to accompany every parcel or lot of the same.

SEC. 4010. Every manufacturer of fish guano, or fertilizers of which the principal ingredient is fish or fish mass from which the oil has been extracted, shall, before manufacturing or heating the same, and within thirty-six hours from the time such fish or mass has been delivered to him, treat the same with sulphuric acid or other chemical, approved by the director of said experiment station, in such quantity as to arrest decomposition: *provided, however,* that in lieu of such treatment such manufacturers may provide a means for consuming all smoke and vapors arising from such fertilizers during the process of manufacture.

SEC. 4011. Any person violating any provisions of the foregoing sections of this chapter shall be fined one hundred dollars for the first offense, and two hundred dollars for each subsequent violation.

SEC. 4012. This chapter shall not affect parties manufacturing, importing, or purchasing fertilizers for their own private use, and not to sell in this State.

SEC. 4013. The Director of the Connecticut Agricultural Experiment Station shall pay the analysis-fees received by him into the treasury of the station, and shall cause one or more analyses of each fertilizer to be made and published annually. Said director is hereby authorized, in person or by deputy, to take samples for analysis from any lot or package of manure or fertilizer which may be in the possession of any dealer.

SEC. 4014. The Director of the Connecticut Agricultural Experiment Station shall, from time to time, as bulletins of said Station may be issued, mail or cause to be mailed two copies, at least, of such bulletins to each post-office in the State.

OBSERVANCE OF THE FERTILIZER LAW.

Here follows an alphabetical list of the manufacturers who have paid analysis fees as required by the Fertilizer Law, and the names or brands of the fertilizers for which fees have been paid by them for the year ending May, 1897.

Firm.	*Brand of Fertilizer.*
Baker, H. J. & Bro., 93 William St., New York City.	Special Corn Manure. Special Potato Manure. A. A. Ammoniated Superphosphate. Special Tobacco Manure. Special Onion Manure. Harvest Home Fertilizer. Castor Pomace.
Berkshire Mills, Bridgeport, Conn.	Berkshire Complete Fertilizer. " Ammoniated Bone Phosphate. " Fish and Potash.
Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	Stockbridge Special Tobacco Manure. " " Grain Manure. " " Grass Top Dressing and Forage Crop Manure. Stockbridge Special Potato and Vegetable Manure. Bowker's Potato Manure. " Hill and Drill Phosphate. " Farm and Garden Phosphate or Ammoniated Bone Fertilizer. " Bone and Potash, Square Brand. " Tobacco Grower. " Sure Crop Phosphate. " Market Garden Manure. Nitrate of Soda. Dissolved Bone Black. Muriate of Potash.
Bradley Fertilizer Co., 92 State St., Boston, Mass.	Bradley's Superphosphate. " Potato Manure. " Complete Manure for Potatoes and Vegetables. " Complete Manure for Top-Dressing Grass and Grain. " Complete Manure for Corn and Grain. " Pure Fine Ground Bone. " Circle Brand, Ground Bone and Potash. " Fish and Potash, Anchor Brand. " Fish and Potash, Triangle A Brand. " B. D. Sea Fowl Guano.

Firm.	*Brand of Fertilizer.*
Bradley Fertilizer Co., 92 State St., Boston, Mass.	Bradley's Original Coe's Superphosphate. " Farmer's New Method Fertilizer. " High Grade Tobacco Manure. " Eclipse Phosphate. " Potato Fertilizer.
Burwell, E. E., New Haven, Conn.	Dried Blood and Meat. Dissolved Bone Black. Double Sulphate Potash and Magnesia. Muriate of Potash. Nitrate of Soda.
Clark's Cove Fertilizer Co., Farlow Building, State St., Boston, Mass.	Bay State Fertilizer. Bay State Fertilizer G. G. Great Planet Manure. Potato and Tobacco Fertilizer. King Philip Guano.
Cleveland Dryer Co., 92 State St., Boston, Mass.	Cleveland Superphosphate. " Potato Phosphate. " Fertilizer.
Clinton, Elbert, Clintonville, Conn.	Ground Bone.
Coe Co., The E. Frank, 133-137 Front St., New York City.	E. Frank Coe's High Grade Potato Fertilizer. E. Frank Coe's High Grade Ammoniated Bone Superphosphate. E. Frank Coe's Alkaline Bone Phosphate. E. Frank Coe's Ground Bone and Potash. " " Gold Brand Excelsior Guano.
Cooper's Glue Factory, Peter, 17 Burling Slip, New York City.	Bone Dust.
Crocker Fertilizer and Chemical Co., Buffalo, New York.	Crocker's General Crop Phosphate. " Universal Grain Grower. " New England Tobacco Grower. " Ammoniated Bone Superphosphate. " Potato, Hop and Tobacco Phosphate. " Ammoniated Wheat and Corn Phosphate. " New Rival Ammoniated Superphosphate. " Special Potato Manure. " Vegetable Bone Superphosphate. " Practical Ammoniated Superphosphate. " Special Connecticut Tobacco Manure. " Pure Ground Bone.

Firm.	*Brand of Fertilizer.*
Cumberland Bone Phosphate Co., State St. and Merchants Row, Boston, Mass.	Cumberland Superphosphate. " Potato Fertilizer. " Concentrated Phosphate. " Fertilizer.
Darling Fertilizer Co., The L. B., Pawtucket, R. I.	Potato and Root Crop Manure. Animal Fertilizer. Garden and Lawn. Tobacco Grower. Fine Bone. Animal "G."
Downs & Griffin, Derby, Conn.	Ground Bone.
Eastern Farm Supply Association, Montclair, N. J.	Carteret Manure for General Use.
Ellsworth, F., Hartford, Conn.	Shoemaker's Swift Sure Bone Meal. " " Superphosphate.
Great Eastern Fertilizer Co., Rutland, Vermont.	Great Eastern General Fertilizer. " " Northern Corn Special Fertilizer. " " Soluble Bone and Potash. " " Vegetable, Vine and Tobacco. " " Garden Special.
Hartford Fertilizer Co, Hartford, Conn.	Ground Bone.
Jefferds, John G., Worcester, Mass.	Ground Bone.
Kelsey, E. R., Branford, Conn.	Bone, Fish and Potash.
Lister's Agricultural Chemical Works, Newark, N. J.	Standard Superphosphate of Lime. Success Phosphate. Special Potato. Animal Bone and Potash.
Lowell Fertilizer Co., Lowell, Mass.	Lowell Bone Fertilizer. " Animal Fertilizer. " Potato Phosphate. " Vegetable and Vine. " Lawn Dressing. " Tobacco Fertilizer.
Luce Bros, Niantic, Conn.	Giant's Neck Superphosphate. Pure Dry Fish Guano. Bone, Fish and Potash.
Ludlam, Frederick, 108 Water St., New York City.	Cecrops or Dragon's Tooth. Cereal Brand.
Lyman, Chas. E., Middlefield, Conn.	Corn Manure. Potato Manure.

Firm.	*Brand of Fertilizer.*
Mapes' Formula and Peruvian Guano Co., 143 Liberty St., New York City.	Potato Manure. Complete Manure for General Use. Fruit and Vine Manure. Corn Manure. Fine Bone Dissolved. Complete Manure for Light Soils or Vegetable Manure. Tobacco Starter. Grass and Grain Spring Top-Dressing. Complete Manure " A " Brand. Tobacco Manure, Wrapper Brand. Seeding Down Manure.
Miles, G. W., Milford, Conn.	Fish Guano. IXL Ammoniated Bone Superphosphate. " Ceres " Complete.
Miller, G. W., Middlefield, Conn.	Ground Bone. Unexcelled Phosphate.
Milsom Rendering and Fertilizer Co., 963 William St., E. Buffalo, N. Y.	Buffalo Fertilizer. Potato, Hop and Tobacco Phosphate. Vegetable Bone Fertilizer. Wheat, Oats and Barley Phosphate. Potato, Hop and Tobacco Phosphate, Long Island Brand. Special Potato Fertilizer. Bone Meal. Erie King. Buffalo Guano. Cyclone Bone Meal. Dissolved Bone and Potash. Dissolved Bone. Buffalo Fertilizer (Long Island Brand).
Niagara Fertilizer Works, Buffalo, New York.	Niagara Wheat and Corn Producer. " Triumph. " Grain and Grass Grower. " Potato, Tobacco and Hop Fertilizer.
National Fertilizer Co., Bridgeport, Conn.	Chittenden's Complete Fertilizer. " Ammoniated Bone Phosphate. " Fish and Potash. " Market Garden. " Potato Phosphate. " Fine Ground Bone.
Nuhn, Frederick, Waterbury, Conn.	Self-Recommending Fertilizer.
Olds & Whipple, Hartford, Conn.	O. & W. Special Phosphate.
Pacific Guano Co., Box 1368, Boston, Mass.	Soluble Pacific Guano. Special Potato Manure. Nobsque Guano. High Grade General Fertilizer.

Firm.	*Brand of Fertilizer.*
Packers' Union Fertilizer Co., Box 1528, New York City.	Potato Manure. Gardeners' Complete Manure. Animal Corn Fertilizer. Oats and Clover Fertilizer. Universal Fertilizer.
Parks, C. D., Danbury, Conn.	Bone Meal. Nameless Fertilizer. Potato Manure.
Peck Bros., Northfield, Conn.	Pure Ground Bone.
Plumb & Winton Co., Bridgeport, Conn.	Ground Bone.
Pouleur, August, Windsor, Conn.	Pure Bone Meal.
Preston Fertilizer Co., Greenport, L. I.	Bone. Superphosphate. Potato, Hop and Onion Fertilizer.
Quinnipiac Co., 92 State St., Boston, Mass.	Quinnipiac Phosphate. " Potato Manure. " Market Garden Manure. " Ammoniated Dissolved Bone. " Fish and Potash, Crossed Fishes. " Fish and Potash, Plain. " Phosphate, Pine Island. " Havana Tobacco Fertilizer. " Grass Fertilizer. " Corn Manure. " Pure Bone Meal. " Dry Ground Fish. Tankage. Muriate of Potash. Sulphate of Potash. Nitrate of Soda. Sulphate of Ammonia. Dissolved Bone Black.
Read Fertilizer Co., Box 3121, New York City.	Read's Standard. Fish and Potash. Vegetable and Vine. Practical Potato Special.
Rogers & Hubbard Co., Middletown, Conn.	The Rogers & Hubbard Co's Pure Raw Knuckle Bone Flour. The Rogers & Hubbard Co's Pure Raw Knuckle Bone Meal. The Rogers & Hubbard Co's Strictly Pure Fine Bone. The Rogers & Hubbard Co's Oats and Top-Dressing. The Rogers & Hubbard Co's Soluble Potato Manure. The Rogers & Hubbard Co's Soluble Tobacco Manure.

Firm.	*Brand of Fertilizer.*
Rogers & Hubbard Co., Middletown, Conn.	The Rogers & Hubbard Co's Grain and Grass Fertilizer. Fairchild's Corn Formula and General Crops. The Rogers & Hubbard Co's Fruit Fertilizer.
Rogers Mfg. Co., Rockfall, Conn.	Potato Manure. Corn Manure. Complete Manure. Pure Ground Bone. Top-Dressing and Oat Manure. Tobacco Manure. Grass and Grain Manure.
Russia Cement Co., Gloucester, Mass.	Essex XXX Fish and Potash. " Manure for Corn and Grain. " Manure for Potatoes and Roots.
Sanderson, L., New Haven, Conn.	Old Reliable Superphosphate. Formula A. Pulverized Bone and Meat. Blood Bone and Meat. Fine Ground Bone. Muriate of Potash. High Grade Sulphate of Potash. Sulphate of Potash. Nitrate of Soda. Sulphate of Ammonia. Dissolved Bone Black.
Standard Fertilizer Co., Farlow Building, State St., Boston, Mass.	Standard Fertilizer. " Potato and Tobacco Fertilizer. " Guano. " Fine Ground Bone. " Complete Manure.
Walker, Stratman & Co., Pittsburgh, Pa.	Four Fold. Potato Special. Smoky City. Butchers' Bone Meal. Pure Raw Bone Meal. Big Bonanza.
Wheeler & Co., M. E., Rutland, Vermont.	High Grade Fruit Fertilizer. Grass and Oats. Potato Manure. High Grade Corn. Superior Truck. Electrical Dissolved Bone.
Wilcox Fertilizer Works, Mystic, Conn.	Wilcox Potato, Onion and Tobacco Manure. Wilcox Ammoniated Bone Phosphate. " Complete Bone Superphosphate. " High Grade Fish and Potash. " Dry Ground Fish Guano.

Firm.	*Brand of Fertilizer.*
Wilkinson & Co., Box 1807, New York City.	Economical Bone Fertilizer.
Williams & Clark Fertilizer Co., 27 William St., New York City.	Americus High Grade Special. " Ammoniated Bone Superphosphate. " Potato Phosphate. " Fine Wrapper Tobacco. " Corn Phosphate. Royal Bone Phosphate. Fish and Potash. Grass Manure. Pure Bone Meal. Americus Potato and Tobacco Fertilizer. Dry Ground Fish Guano.

SAMPLING AND COLLECTION OF FERTILIZERS.

During April, May and June, Mr. C. L. Backus of Andover, the sampling agent of this Station, visited ninety-four towns and villages of Connecticut to draw samples of Commercial Fertilizers for analysis. These places were distributed as follows:

Litchfield County, . . .	8
Hartford " . . .	23
Tolland, " . . .	10
Windham " . . .	7
New London " . . .	10
Middlesex " . . .	5
New Haven " . . .	16
Fairfield " . . .	15
	94

In these places the agent drew 589 samples, representing 229 brands of fertilizers.

In this way one or more samples were secured of most of the brands of fertilizers which are offered for sale within the State. When several samples of a single brand were drawn in different parts of the State the analysis was performed, not on any single sample, but on a mixture made of an equal weight of each of the several samples. Thus, it is believed, the average composition of the goods is more fairly represented than by the analysis of any single sample.

The Station agent is instructed in every case to open at least three packages of each brand for sampling, and if the number of packages is large, to take a portion from every tenth one, by means of a sampling tube which withdraws a section or core through the entire length of the bag or barrel.

As a rule, the Station will not analyze samples taken—

1. From dealer's stock of less than one ton.
2. From stock which has lain over from last season.
3. From stock which evidently is improperly stored, as in bags lying on wet ground or exposed to the weather, etc.

The Station desires the coöperation of farmers, farmers' clubs and granges in calling attention to new brands of fertilizers, and in securing samples of all goods offered for sale. *All samples must be drawn in strict accordance with Station's Instructions for Sampling, and must also be properly certified*, if the Station analysis is desired. A copy of these instructions and blank certificates will be sent on application.

ANALYSES OF FERTILIZERS.

During the year, 492 samples of commercial fertilizers and manurial waste-products have been analyzed. A classified list of them is given on page 100.

On a few of these samples analyses were made for private parties and charged for accordingly. A few samples also were analyzed at the request of other Experiment Stations in order to compare and test analytical methods. Results of the examination of all the samples, with these exceptions, are given in detail in the following pages.

Samples are analyzed as promptly as possible in the order in which they are received. As soon as an analysis is completed a copy of it is sent to the party who furnished the sample, and also to the manufacturer, in order that there may be opportunity for correction or protest, before the results are published.

The following "Explanations" are intended to embody the principles and data upon which the valuation of fertilizers is based, a knowledge of which is essential to a correct understanding of the analyses that are given on subsequent pages.

EXPLANATIONS CONCERNING THE ANALYSIS OF FERTILIZERS AND THE VALUATION OF THEIR ACTIVE INGREDIENTS.*

THE ELEMENTS OF FERTILIZERS.

The three chemical elements whose compounds chiefly give value, both commercial and agricultural, to fertilizers, are Nitrogen, Phosphorus and Potassium. The other elements found in fertilizers, viz: Sodium, Calcium, Magnesium, Iron, Silicon, Sulphur, Chlorine, Carbon, Hydrogen and Oxygen, which are necessary or advantageous to the growth of vegetation, are either so abundant in the soil or may be so cheaply supplied to crops, that they do not considerably affect either the value or cost of high-priced commercial fertilizers.

NITROGEN in fertilizers is, on the whole, the least abundant of their valuable elements, and is, therefore, their most costly ingredient.

Free Nitrogen is universally abundant, making up nearly four-fifths of the common air, and appears to be directly assimilable by various low vegetable organisms, and with aid of certain bacteria, by leguminous plants (the clovers, alfalfa, peas, beans, lentils, esparsette, lupins, vetches, lathyrus, peanut, yellow locust, honey locust, etc.), and by a few non-leguminous plants, carrying root nodules, viz: the Oleasters (*Eleagnus*), the Alders (*Alnus*), and a single family of coniferous trees (*Podocarpus*), but not at all, according to present evidence, by the cereals or other field and garden crops.

Organic Nitrogen is the nitrogen of animal and vegetable matters which is chemically united to carbon, hydrogen and oxygen. Some forms of organic nitrogen, as those of blood, flesh and seeds, are highly active as fertilizers; others, as found in leather and peat, are comparatively slow in their effect on vegetation, unless these matters are chemically disintegrated. Since organic nitrogen may often readily take the form of ammonia, it has been termed *potential ammonia.*

Ammonia (NH_3) *and Nitric Acid* (N_2O_5) are results of the chemical change of *organic nitrogen* in the soil and manure heap, and contain nitrogen in its most active forms. They occur in commerce—the former in sulphate of ammonia, the latter in nitrate of soda: 17 parts of ammonia, or 66 parts of pure sulphate of ammonia, contain 14 parts of nitrogen: 85 parts of pure nitrate of soda also contain 14 parts of nitrogen.

PHOSPHORUS is, next to nitrogen, the most costly ingredient of fertilizers, wherein it exists in the form of phosphates, usually those of calcium, iron and aluminum, or in case of "superphosphates," to some extent in the form of free phosphoric acid.

Water-soluble Phosphoric Acid is phosphoric acid (or a phosphate) that freely dissolves in water. It is the characteristic ingredient of superphosphates, in which it is produced by acting on "insoluble" (or

* Prepared and revised by the Director.

"citrate soluble") phosphates, with diluted sulphuric acid. Once well incorporated with the soil, it gradually "reverts" and becomes insoluble, or very slightly soluble, in water.

Citrate-soluble Phosphoric Acid signifies the phosphoric acid (of various phosphates) that is freely taken up by a hot strong solution of neutral ammonium citrate, which solution is therefore used in analysis to determine its quantity. The designation *citrate-soluble* is synonymous with the less explicit terms *reverted*, *reduced* and *precipitated*, which all imply phosphoric acid that was once easily soluble in water, but from chemical change has become insoluble in that liquid.

Recent investigation tends to show that water-soluble and citrate-soluble phosphoric acid are on the whole about equally valuable as plant food, and of nearly equal commercial value. In some cases, indeed, the water-soluble gives better results on crops; in others the "reverted" is superior. In most instances there is probably little to choose between them.

Insoluble Phosphoric Acid implies various phosphates insoluble both in water and in hot solution of neutral ammonium citrate. The phosphoric acid of Canadian "Apatite," of South Carolina and Florida "Rock Phosphate" and of similar dense mineral phosphates, as well as that of "bone ash" and "bone black," is mostly insoluble in this sense, and in the majority of cases gives no visible good results when these substances, in the usual ground state, are applied to crops. They contain, however, a small proportion of citrate-soluble phosphoric acid, and sometimes, when they are reduced to extremely fine dust (floats) or applied in large quantities, especially on "sour soils" or in conjunction with abundance of decaying vegetable matter (humus), they operate as efficient fertilizers.

Available Phosphoric Acid is an expression properly employed in general to signify phosphoric acid in any form, or phosphates of any kind that serve to nourish vegetation. In the soil, phosphoric acid and all phosphates, whatever their solubilities as defined in the foregoing paragraphs, are more or less freely and extensively available to growing plants. Great abundance of "insoluble" phosphoric acid may serve crops equally well with great solubility of a small supply, especially when the soil and the crop carry with them conditions highly favorable to the assimilation of plant food.

In Commercial Fertilizers, "available phosphoric acid" is frequently understood to be the sum total of the "water soluble" and the "citrate-soluble," with the exclusion of the "insoluble."

The "insoluble phosphoric acid" in a commercial fertilizer costing $20 to $50 per ton, has very little or no value to the purchaser, because the quantity of it which can commonly go upon an acre of land has no perceptible effect upon the crop, and because its presence in the fertilizer excludes an equal percentage of more needful and much more valuable ingredients.

In Raw Bone the phosphoric acid (calcium phosphate) is nearly insoluble, because of the animal matter of the bones which envelops it; but when the animal matter decays in the soil, or when it is disinte-

grated by boiling or steaming, the phosphate mostly remains in an available form. The phosphoric acid of "Basic-Slag" and of "Grand Cayman's Phosphate" is in some soils as freely taken up by crops as water-soluble phosphoric acid, but in other soils is much less available than the latter.

Phosphoric acid in all the Station analyses is reckoned as "anhydrous phosphoric acid" (P_2O_5), also termed among chemists phosphoric anhydride, phosphoric oxide, and phosphorus pentoxide.

POTASSIUM is the constituent of fertilizers which ranks third in costliness. In plants, soils and fertilizers, it exists in the form of various salts, such as chloride (muriate), sulphate, carbonate, nitrate, silicate, etc. Potassium itself is scarcely known except as a chemical curiosity.

Potash signifies the substance known in chemistry as potassium oxide (K_2O), which is reckoned as the valuable fertilizing ingredient of "potashes" and "potash salts." In these it should be freely soluble in water and is most costly in the form of sulphate, and cheapest in the form of muriate (potassium chloride). In unleached ashes of wood and of cotton-seed hulls it exists mainly as potassium carbonate.

VALUATION OF FERTILIZERS.

The valuation of a fertilizer, as practised at this Station, consists in calculating the *retail Trade-value* or *cash-cost* (in raw material of good quality) of an amount of nitrogen, phosphoric acid and potash equal to that contained in one ton of the fertilizer.

Plaster, lime, stable manure and nearly all of the less expensive fertilizers have variable prices, which bear no close relation to their chemical composition, but guanos, superphosphates and similar articles, for which $30 to $50 per ton are paid, depend for their trade-value exclusively on the substances *nitrogen, phosphoric acid and potash,* which are comparatively costly and steady in price. The trade-value per pound of these ingredients is reckoned from the current market prices of the standard articles which furnish them to commerce.

The consumer, in estimating the reasonable price to pay for high-grade fertilizers, should add to the *Trade-value of the above named ingredients* a suitable margin for the expenses of manufacture, etc., and for the convenience or other advantage incidental to their use.

TRADE-VALUE OF FERTILIZER ELEMENTS, FOR 1896.*

The average trade-values or retail costs in market, per pound, of the ordinarily occurring forms of nitrogen, phosphoric acid and potash in raw materials and chemicals, as found in New England, New York and New Jersey markets during 1895, were as follows:

* Adopted at a conference of representatives of the Connecticut, Massachusetts, New Jersey and Rhode Island Stations held in March, 1896.

	Cts. per lb.
Nitrogen in ammonia salts	15
nitrates	13½
Organic nitrogen in dry and fine ground fish, meat and blood and in mixed fertilizers	14
in cotton seed meal	12
in fine* bone and tankage	13½
in fine-medium* bone and tankage	12
in medium* bone and tankage	9
in coarse* bone and tankage	3
Phosphoric acid, water-soluble	5½
citrate-soluble †	5
of dry ground fine fish, bone and tankage	5
of fine-medium bone and tankage	4
of medium bone and tankage	2½
of coarse bone and tankage	2
of fine ground fish, cotton seed meal, castor pomace and wood ashes	4½
of mixed fertilizers (insoluble in ammonium citrate)	2
Potash as high-grade sulphate and in forms free from muriate (or chlorides)	5
as muriate	4½

The foregoing are, as nearly as can be estimated, the prices at which, during the six months preceding March last, the respective ingredients were retailed for cash, in our large markets, in those *raw materials* which are the regular source of supply. They also correspond to the average wholesale price for the six months ending March 1st, plus about 20 per cent. in case of goods for which we have wholesale quotations. The valuations obtained by use of the above figures will be found to correspond fairly with the *average retail prices* at the large markets of standard raw materials, such as:

Sulphate of Ammonia,	Muriate of Potash,
Nitrate of Soda,	Sulphate of Potash,
Dried Blood,	Plain Superphosphates,
Azotin,	Dry Ground Fish,
Ammonite,	Bones and tankage,

Ground South Carolina Rock.

* Fine signifies smaller than $\frac{1}{50}$ inch; fine-medium between $\frac{1}{50}$ and $\frac{1}{25}$ inch; medium between $\frac{1}{25}$ and $\frac{1}{12}$ inch; coarse larger than $\frac{1}{12}$ inch.

† Dissolved from 2 grams of the fertilizer, previously extracted with pure water, by 100 c.c. neutral solution of ammonium citrate, sp. gr. 1.09, in 30 minutes, at 65° C., with agitation once in five minutes. Commonly called "reverted" or "backgone" Phosphoric Acid.

VALUATION OF SUPERPHOSPHATES, SPECIAL MANURES AND MIXED FERTILIZERS OF HIGH GRADE.

The Organic Nitrogen in these classes of goods is reckoned at the price of nitrogen in raw materials of the best quality, 14 cents.

Insoluble Phosphoric Acid is reckoned at 2 cents per pound. Potash is rated at 4½ cents, if sufficient chlorine is present in the fertilizer to combine with it to make muriate. If there is more Potash present than will combine with the chlorine, then this excess of Potash is reckoned at 5 cents per pound.

In most cases the valuation of the ingredients in superphosphates and specials falls below the retail price of these goods. The difference between the two figures represents the manufacturer's charges for converting raw materials into manufactured articles and selling them. The charges are for grinding and mixing, bagging or barreling, storage and transportation, commission to agents and dealers, long credits, interest on investments, bad debts and, finally, profits.

The majority of the manufacturers agree that the average cost of mixing, bagging, handling and cartage ranges from $3.00 to $4.50 per ton.

In 1896 the average selling price of Ammoniated Superphosphates and Guanos was $31.56 per ton, the average valuation was $21.18 and the difference $10.38, an advance of 49.0 per cent. on the valuation and on the wholesale cost of the fertilizing elements in the raw materials.

In case of Special manures the average cost was $36.19, the average valuation $25.64 and the difference $10.55 or 41.1 per cent. advance on the valuation.

To obtain the Valuation of a Fertilizer we multiply the pounds per ton of nitrogen, etc., by the trade-value per pound. We thus get the values per ton of the several ingredients, and adding them together we obtain the total valuation per ton.

In case of *Ground Bone and Tankage*, the sample is sifted into the four grades just specified (see foot note, page 97), and we separately compute the nitrogen-value of each grade by multiplying the pounds of nitrogen per ton by the per cent. of each grade, taking $\frac{1}{100}$th of that product, multiplying it by the trade-value per pound of nitrogen in that grade, and taking this final product as the result in cents. Summing up the separate values of each grade thus obtained, together with the values of each grade of phosphoric acid, similarly computed, the total is the Valuation of the sample of bone. See page 97.

USES AND LIMITATIONS OF FERTILIZER VALUATION.

The uses of the "Valuation" are two-fold:

1. To show whether a given lot or brand of fertilizer is worth, as a commodity of trade, what it costs. If the selling price is not higher than the valuation, the purchaser may be tolerably sure that the price is reasonable. If the selling price is twenty to twenty-five per cent. higher than the valuation, it may still be a fair price; but in proportion as the cost per ton exceeds the valuation there is reason to doubt the economy of its purchase.

2. Comparisons of the valuation and selling prices of a number of similar fertilizers will generally indicate fairly which is the best for the money.

But the valuation is not to be too literally construed, for in some cases analysis cannot discriminate positively between the active and the inert forms of nitrogen, while the mechanical condition of a fertilizer is an item whose influence cannot always be rightly expressed or appreciated.

For the above first named purpose of valuation, the trade-values of the fertilizing elements which are employed in the computations should be as exact as possible, and should be frequently corrected to follow the changes of the market.

For the second named use of valuation frequent changes of the trade-value are disadvantageous, because two fertilizers cannot be compared as to their relative money-worth when their valuations are deduced from different data.

Experience leads to the conclusion that the trade-values adopted at the beginning of the year should be adhered to as nearly as possible throughout the year, notice being taken of considerable changes in the market, in order that due allowance may be made therefor.

Agricultural Value of Fertilizers.

The Agricultural Value of a fertilizer is measured by the benefits received from its use, and depends upon its fertilizing effect, or crop-producing power. As a broad, general rule, it is true that ground bone, superphosphates, fish-scraps, dried blood, potash salts, etc., have a high agricultural value which is related to their trade-value, and to a degree determines the latter value. But the rule has many exceptions, and in particular instances the trade-value cannot always be expected to fix or even to indicate the agricultural value. Fertilizing effect depends largely upon soil, crop and weather, and as these vary from place to place, and from year to year, it cannot be foretold or estimated except by the results of past experience, and then only in a general and probable manner.

CLASSIFICATION OF FERTILIZERS ANALYZED.

RAW MATERIALS.

1. *Containing Nitrogen as the Chief Valuable Ingredient.*

Nitrate of Soda	12
Sulphate of Ammonia	2
Dried Blood	1
Horn and Hoof	1
Cotton Seed Meal	51
Linseed Meal	9
Castor Pomace	7
Mustard Seed Cake	1
Preparations of Leather	4

2. *Containing Phosphoric Acid as the Chief Valuable Ingredient.*

Odorless Phosphate	1
Dissolved Bone Black	5
Dissolved Rock Phosphate	8

3. *Containing Potash as the Chief Valuable Ingredient.*

High Grade Sulphate of Potash	7
Double Sulphate of Potash and Magnesia	8
Phosphate of Potash	1
Muriate of Potash	12
"Potash Salts"	1

4. *Containing Nitrogen and Phosphoric Acid.*

Bone Manures	51
Tankage	13
Fish	11

MIXED FERTILIZERS.

Bone and Potash	3
Nitrogenous Superphosphates	116
Special Manures	95
Home Mixtures	11

MISCELLANEOUS FERTILIZERS AND MANURES.

Cotton Hull Ashes	33
Wood Ashes	19
Lime Kiln Ashes	2
Tobacco Stems and Dust	4
Muck	1
Peas and Beans	2
	492

DESCRIPTION AND ANALYSES OF FERTILIZERS.*

The samples referred to in the following pages, unless the contrary is stated, were drawn by an agent of the Station.

I. RAW MATERIALS CHIEFLY VALUABLE FOR NITROGEN.

NITRATE OF SODA OR SODIUM NITRATE.

Nitrate of Soda is mined in Chili and purified there before shipment. It contains about 16 per cent. of nitrogen, equivalent to 97 per cent. of pure sodium nitrate. The usual guarantee is "96 per cent." of sodium nitrate, equivalent to 15.8 per cent. of nitrogen.

In rare cases cargoes have been found to contain sodium perchlorate which, even in small amount, is very injurious to vegetation.†

5801. Sold by the Mapes' Formula and Peruvian Guano Co., N. Y. Sampled and sent by H. G. Manchester, West Winsted.

5802. Sold by L. Sanderson, New Haven. Sampled and sent by H. G. Manchester.

6099. Sold by Quinnipiac Co., through Olds & Whipple, Hartford.

6100. Sold by Mapes' Branch, Hartford.

6142. Sold by L. Sanderson, New Haven. Sampled and sent by C. B. Sheldon, West Suffield.

6244. Sold by Taylor & Brush, N. Y. City. Sampled and sent by W. F. Whitney, Yalesville.

6261. Sold by Bowker Fertilizer Co., through W. O. Goodsell, Bristol.

6263. Sold by E. E. Burwell, East Haven. Sampled and sent by him.

6290. Sold by Taylor & Brush, N. Y. City. Sampled and sent by A. E. Plant, Branford.

6340. Sold by Bradley Fertilizer Co., Boston. Sampled and sent by C. J. Dewey, Buckland.

6344. Sold by L. Sanderson, New Haven.

6479. Bought by the Station of L. Sanderson for use in vegetation experiments.

All these samples, as is shown in the table, were of average composition, the per cent. of nitrogen ranging from 15.53 to 16.21.

The cost of nitrogen per pound has varied from 12.7 to 15.0 cents.

* This chapter, pp. 101 to 168, with exception of pp. 156 to 163, has been prepared for publication by Dr. Jenkins. The analyses of fertilizers have all been made by Messrs. Winton, Ogden and Mitchell, chemists of the Station, with the assistance of Mr. Lange.

† Landw. Presse XXIII: 1896, 615.

ANALYSES OF NITRATE OF SODA.

	5801	5802	6099	6100	6142	6244	6261	6263	6290	6340	6344	6479
Moisture	2.36	2.50	1.00	2.09	2.23	1.70	2.00	2.28	1.54	2.49	1.75	......
Insoluble in Water	.19	.30	.11	.08	.33	.12	.15	.17	.11	.33	.19	......
Common Salt	.70	.95	.46	.74	1.71	.41	1.72	.64	.43	1.37	.89	......
Sodium Sulphate	.27	2.12	.12	.18	.34	.14	.30	.24	.11	.46	.20	......
Sodium Nitrate	96.48	94.13	98.31	96.91	95.39	97.63	95.83	96.67	97.81	95.35	96.97	......
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	
Equivalent Nitrogen	15.90	15.53	16.21	15.98	15.73	16.10	15.81	15.94	16.14	15.73	15.99	15.77
Cost per ton	......	......	$46.00	44.00	45.00	......	45.00	48.00	......	40.00	48.00	......
Nitrogen costs cents per pound	......	......	14.2	13.8	14.3	......	14.2	15.0	......	12.7	15.0	......

Sulphate of Ammonia, or Ammonium Sulphate.

This article, now made on a large scale as a by-product of gas works and coke ovens, usually contains over 20 per cent. of nitrogen, the equivalent of 94–97 per cent. of ammonium sulphate. The rest is chiefly moisture. The usual guarantee is 25 per cent. of ammonia, which is equivalent to 20.6 per cent. of nitrogen.

6300. Sold by the Quinnipiac Co., Boston, through Olds & Whipple, Hartford.

6343. Sold by L. Sanderson, New Haven.

Analyses of Sulphate of Ammonia

	6300	6343
Nitrogen	20.92	20.84
Equivalent Ammonia	25.40	25.30
Cost per ton	$65.00	70.00
Nitrogen costs cents per pound	**15.5**	**16.8**

Dried Blood.

This consists of slaughter-house blood which has been dried by superheated steam or hot air. It is a finely pulverized, nearly odorless substance, red or nearly black in color, and rich in nitrogen that is quickly available to vegetation.

A sample of this material, **6021**, used in the Station vegetation experiments, contained 13.58 per cent. of nitrogen.

Ground Horn and Hoof.

We are informed that this material is made in Chicago from horns and hoofs that are steamed under high pressure, which makes them brittle, so that they can be ground to a fine powder.

A single sample, **6020**, obtained for vegetation experiments, contained 15.33 per cent. of nitrogen.

Cotton Seed Meal.

This material is of two kinds, which are known in trade respectively as undecorticated and decorticated. In their manufacture cotton seed is first ginned to remove most of the fiber, then passed through a "linter" to take off the short fiber or lint

ANALYSES OF DECORTICATED COTTON SEED MEAL.

Station No.	Dealer.	Sampled by	Nitrogen.	Phosphoric Acid.	Potash.	Cost per Ton.	Nitrogen costs cents per pound.
6051	Olds & Whipple, Hartford	Walter W. Pratt, East Hartford	8.09	2.81	1.85	$22.50	11.2
6068	Olds & Whipple, Hartford	Eugene Brown, Windsor	8.17	2.81	1.85	23.00	11.3
6144	D. L. Brockett, Suffield	Chas. B. Sheldon, Suffield	7.67	2.81	1.85	22.00	11.5
6293	W. F. Fletcher, Southwick, Mass.	L. R. Griffin, Granby	7.85	2.81	1.85	22.50	11.5
6296	L. J. Grant, Wapping	Station Agent	8.12	2.81	1.85	23.00	11.5
6113	James Perkins	James P. Spencer, Suffield	7.36	2.81	1.85	21.50	11.6
6171	American Cotton Oil Co.	R. W. Cowles, Tariffville	7.30	2.81	1.85	21.50	11.7
6151	C. H. Dexter's Sons, Windsor Locks	James Tobin, Windsor Locks	7.28	2.81	1.85	21.50	11.8
6172	C. M. Cox & Co., Boston, Mass.	R. W. Cowles, Tariffville	6.76	2.81	1.85	20.50	12.9
6028	Daniels Mill Co, Hartford	William Daly, East Windsor Hill	7.11	2.81	1.85	21.50	12.0
6045	J. E. Perkins, Suffield	F. B. Hathaway, Windsor Locks	7.06	2.81	1.85	21.50	12.1
6103	C. H. Dexter's Sons, Windsor Locks	John Mackey, Windsor Locks	7.26	2.81	1.85	22.00	12.1
6152	Daniels Mill Co., Hartford	Dan. O. King, Windsor Locks	7.18	2.81	1.85	22.00	12.3
6108	C. H. Dexter & Son, Windsor Locks	Charles D. Cannon, Windsor Locks	7.16	2.81	1.85	22.00	12.3
6069	Arthur Sykes, Suffield	E. M. Barnes, Thompsonville	7.22	2.81	1.85	22.25	12.3
6319	David Brockett, Suffield	Francis Granger, East Granby	7.50	2.81	1.85	23.00	12.4
5440	Olds & Whipple, Hartford	William S. Pinney, Suffield	7.09	2.81	1.85	22.00	12.4
5811	J. M. Williams, Manchester	W. H. Olcott, South Manchester	7.28	2.81	1.85	22.50	12.4
6140	C. H. Dexter & Son, Windsor Locks	John P. Griswold, Poquonock	7.12	2.81	1.85	22.00	12.4
6187	H. S. Chapman, 211 Broadway, N.Y.	H. S. Chapman & Co., Thompsonville	6.85	2.81	1.85	21.50	12.5
6037	James Perkins, Suffield	Charles H. Wells, Suffield	6.89	2.81	1.85	21.75	12.6
5888	Daniels Mill Co., Hartford	E. F. Thompson, Warehouse Point	6.81	2.81	1.85	21.50	12.6

ANALYSES OF DECORTICATED COTTON SEED MEAL.—*Continued.*

Station No.	Dealer.	Sampled by	Nitrogen.	Phosphoric Acid.	Potash.	Cost per Ton.	Nitrogen costs cents per pound.
6339	C. M. Cox & Co., Boston, Mass.	C. J. Dewey, Buckland	7.00	2.81	1.85	$22.00	12.6
5890	James Perkins, Suffield	Charles A. Birge, Suffield	7.00	2.81	1.85	22.00	12.6
5765	F. W. Brode & Co,	Lowell H. Brewer, Hockanum	6.96	2.81	1.85	22.00	12.7
6294	W. F. Fletcher, Southwick, Mass.	Alfred H. Griffin, Granby	7.11	2.81	1.85	22.50	12.7
6240	August Pouleur, Windsor	A. C. Bedortha, Windsor	7.13	2.81	1.85	22.75	12.9
6241	August Pouleur, Windsor	A. C. Bedortha, Windsor	7.04	2.81	1.85	22.75	13.0
6262	Chas. Cox & Co., Boston, Mass.	Carey Brothers, Windsor	7.06	2.81	1.85	22.75	13.0
6275	W. S. Pinney, Suffield	J. Edgar Phelps, Thompsonville	7.14	2.81	1.85	23.00	13.0
6053	W. W. Cooper, Suffield	C. D. Woodworth, Thompsonville	6.90	2.81	1.85	22.50	13.1
6036	W. W. Cooper, Suffield	Charles H. Wells, Suffield	6.91	2.81	1.85	22.50	13.1
6047	H. C. Aborn & Son, Ellington	H. W. Kibbe, Ellington	7.00	2.81	1.85	23.00	13.3
6112	W. W. Cooper, Suffield	O. C. Rose, West Suffield	6.71	2.81	1.85	22.50	13.5
6094	Joel H. Brewer, Hillstown	Station Agent	6.82	2.81	1.85	23.00	13.6
6117	W. W. Cooper, Suffield	E. J. Sheldon, West Suffield	6.66	2.81	1.85	22.50	13.6
5889	Daniels Mill Co., Hartford	Charles Pomroy, Suffield	6.28	2.81	1.85	21.50	13.6
6249	S. D. Viets, Springfield, Mass.	Virgil E. Viets, Copper Hill	6.68	2.81	1.85	22.50	13.6
6368	I. B. Phelan & Son, Windsor Locks	Charles A. Birge, Suffield	6.52	2.81	1.85	22.25	13.7
6150	James Perkins, Suffield	Charles A. Birge, Suffield	6.36	2.81	1.85	21.75	13.7
6110	W. W. Cooper, Suffield	Henry M. Rose, West Suffield	6.54	2.81	1.85	22.50	13.8
6046	J. E. Perkins, Suffield	E. S. Seymour, Windsor Locks	6.32	2.81	1.85	22.00	13.9
6029	T. B. Atwater, Plantsville	Miss M. A. Neale, Southington	6.32	2.81	1.85	24.00	15.5

remaining, then through machines which break and separate the hulls. The hulled seed is ground and the oil expressed. The ground cake from the presses is used as a cattle food and fertilizer. The hulls are burned for fuel in the oil factory and the ashes, which contain from 20 to 30 per cent. of potash, are also used as a fertilizer. In case of undecorticated meal the hulls and the ground press-cake are mixed together.

Nitrogen alone has been determined in most of the samples whose analyses follow. In these cases the per cents. of phosphoric acid and potash given in the table are the averages derived from all the analyses of decorticated meal made in the last two years at this Station. The per cent. amounts of phosphoric acid and potash in clear cotton seed meal do not vary so much in different samples as to make their determination necessary in order to determine the general quality of the sample.

Decorticated (hulled) Cotton Seed Meal.

In the table on pages 104 and 105 are given the analyses of forty-three samples of this material.

In the last column of the table is given the cost of nitrogen in each sample, valuing the phosphoric acid and potash in each at 4½ and 5 cents per pound respectively.

It appears that the nitrogen of decorticated meal has ranged from 8.17 to 6.28, averaging 7.05 per cent.

The retail cash cost per pound of nitrogen has ranged from 11.2 to 15.5 cents per pound, and the average cost has been 12.7 cents.

Decorticated Cotton Seed Meal continues to be the cheapest source of available nitrogen. Experiments indicate that it is as rapidly and fully available as the best forms of animal matter.

Undecorticated (Unhulled) Cotton Seed Meal.

The following analyses of dark, undecorticated meal, show the average composition of such goods :

6048 and **6134**, sent by Edgar Brewer, Hockanum.

5625. Sold as a mixture of hulls and meal by F. W. Brode & Co., Memphis, Tenn. Sampled and sent by L. H. Brewer, Hockanum.

ANALYSES OF UNDECORTICATED COTTON SEED MEAL.

	6018	6184	5625
Nitrogen	4.42	4.20	3.89
Phosphoric Acid	....	2.06	....
Potash	....	1.59	....
Cost per ton	$17.00	17.00	17.00
Nitrogen costs cents per pound	....	16.1	

Since the unhulled meal is sold for $5.00 less per ton than the bright yellow decorticated meal, it has been questioned whether the former might not be a cheaper source of nitrogen than the latter.

The analysis 6184 shows that nitrogen in the unhulled dark meal costs about 3½ cents per pound more than in prime yellow meal, and that it is a waste of money to buy "low grade" rather than "high grade" meal for use as a fertilizer at present prices.

LINSEED MEAL.

This material is the ground residue left after the extraction of oil either by pressure or solvents from linseed (flax seed). It has long been prized as a cattle feed, and during the season of 1896 was sold at prices which induced a considerable number of tobacco growers to use it as a fertilizer, apparently with good effect.

6052. Sold by Olds & Whipple, Hartford. Sampled and sent by J. A. DuBon, Poquonock.

6078. Sold by W. E. Pinney, Suffield. Sampled and sent by A. C. Russell, Suffield.

6276. Sold by Daniels Mill Co., Hartford. Sampled and sent by E. P. Brewer, Silver Lane.

6077. Specially prepared and screened New Process Linseed Meal. Made by Cleveland Oil Co., Cleveland, O. Sold by Olds & Whipple, Hartford. Sampled and sent by Clark Bros., Poquonock.

5627. Same stock as **6077.** Sampled by Olin Wheeler, Buckland.

6102. Sample of a car load bought of Cleveland Linseed Oil Co. Sampled and sent by E. F. Miller.

6217. Stock used in the Station tobacco experiments.

6027. Stock used in the Station vegetation experiments.

ANALYSES OF LINSEED MEAL.

	6052	6078	6276	6077	5627	6102	6217	6027
Nitrogen	6.93	6.62	6.28	6.67	6.48	6.28	6.72	5.10
Phosphoric Acid	1.96	1.92	1.83	1.69	1.66	1.69	1.89	....
Potash	1.24	1.07	1.30	1.05	1.41	1.26	1.30	....
Cost per ton	$20.00	19.50	19.00	20.00	20.00	20.00	....	....
Nitrogen costs cents per pound	12.3	12.6	12.8	13.0	13.2	13.7	....	

The average cost per pound of nitrogen in these samples has been about 13 cents, .3 cents per pound higher than in cotton seed meal.

CASTOR POMACE.

This is the ground residue of castor beans from which castor oil has been extracted. It is an excellent fertilizer, but extremely poisonous to animals, which often eat it greedily when the opportunity offers.

6297. Sold by Bowker Fertilizer Co., Boston. Stock of S. T. Weldon, Simsbury, and H. K. Brainard, Thompsonville.

6114. Made by H. J. Baker & Bro., N. Y. City. Stock of Webster & Atwater, New Britain.

6295. Stock of W. S. Pinney, Suffield. Sampled and sent by G. A. Harmon, Suffield.

6483. Stock of S. T. Weldon, Simsbury. Sampled and sent by A. L. Eno, Simsbury.

6220. Bought for use in the Station tobacco experiments.

6022. Red Seal Castor Pomace used in Station vegetation experiments.

6024. Collier Pomace used in Station vegetation experiments.

ANALYSES OF CASTOR POMACE.

	6297	6114	6295	6483	6220	6022	6024
Nitrogen	4.92	4.85	4.74	4.30	4.72	4.96	4.73
Phosphoric Acid	1.87	2.98	1.79	1.29	1.89	....	....
Potash	1.00	1.00	1.10	1.10	1.06	....	....
Cost per ton	$18.00	20.50	20.00	20.00	....	....	....
Nitrogen costs cents per pound	15.6	17.3	18.2	20.6	....	....	....

Castor Pomace is an expensive form of organic nitrogen at present prices and is used chiefly by certain tobacco growers who still prefer it to cotton seed meal. The Poquonock experiments indicate that cotton seed meal in equivalent quantity yields tobacco of the same quality in all respects as castor pomace, and at a much lower cost for fertilizers.

Mustard Seed Cake.

A sample of this material **6133**, sent by the Oil Seeds Pressing Co., N. Y. City, contained 4.93 per cent. of nitrogen, 2.00 of phosphoric acid and 1.12 of potash.

If sold for $16.00 or less per ton it would be as cheap a source of nitrogen as cotton seed and linseed meal.

Preparations of Leather.

As has been proved abundantly by experiment, leather, whether in its untreated state or steamed, or roasted and pulverized, has little value as a fertilizer. The State fertilizer law wisely forbids its use in any form as an ingredient of commercial fertilizers without explicit printed certificate of the fact, "such certificate to be conspicuously affixed to every package," etc.

The materials on which the following analyses were made were used in vegetation experiments to be described on following pages.

6134. Hemlock-tanned sole leather.

6135. Steamed leather, prepared from a portion of sample **6134** by heating it with water in the autoclave for two hours, under a pressure of 60 pounds to the square inch and drying the resulting gummy mass on the water bath.

6131. Roasted leather prepared from **6134** by heating the powdered leather, at 240° C. for four hours.

6136. Dissolved leather. 148 grams of sample **6134** and 100 grams of oil of vitriol, sp. gr. 1.84, were heated gradually, with constant stirring, till fumes of sulphurous acid appeared. Water was added and the mass digested, evaporated to dryness, and heated till sulphurous acid was evolved. Water was again added, the acid was nearly neutralized with carbonate of lime, and the whole dried on the water-bath.

Analyses of Leather.

	Raw Leather. 6134	Steamed Leather. 6135	Roasted Leather. 6131	Dissolved Leather, etc. 6136
Nitrogen	6.76	7.40	8.66	2.51

II. RAW MATERIALS OF HIGH GRADE CONTAINING PHOSPHORIC ACID AS THE CHIEF VALUABLE INGREDIENT.

Odorless Phosphate.

This material is pulverized basic Slag, a bye-product from the steel manufacture, similar to so-called Thomas Slag.

6444. Sold by Jacob Reese, 400 Chestnut St., Phila. Sampled from stock of A. J. Palmer, Branford.

It contained 18.72 per cent. of phosphoric acid, of which 7.81 per cent. is soluble in ammonium citrate by the conventional method used in the analysis of superphosphates.

Dissolved Bone Black.

Bone Black, made by subjecting bone to a red heat without access of air, is used in sugar refineries to decolorize sugar solutions. The waste bone black dried, and treated with oil of vitriol, makes a "superphosphate" of high grade which does not cake together on standing, but remains as a fine powder suitable for application to the land.

5899. Sold by L. Sanderson, New Haven.

6305. Sold by Bowker Fertilizer Co., through H. K. Brainard, Thompsonville.

6267. Sold by E. E. Burwell, Fair Haven. Sample sent by him.

5803. Sold by Mapes' F. & P. G. Co., N. Y. Sampled and sent by H. G. Manchester, West Winsted.

5804. Sold by L. Sanderson. Sampled and sent by H. G. Manchester, West Winsted.

Dissolved Rock Phosphate or Acid Rock.

This material, made by treating various mineral phosphates with oil of vitriol, is the most common source of the phosphoric acid of factory-mixed fertilizers.

6089. Sold by the Quinnipiac Co. through Olds & Whipple, Hartford.

6415. Electrical Dissolved Bone, made by M. E. Wheeler & Co., Rutland, Vt. From stock of Chas. J. Abell, Lebanon.

6428. Dissolved Bone, made by the Milsom Rendering and Fertilizer Co., Buffalo, N. Y., and sampled by them.

5900. Sold by the Berkshire Mills, Bridgeport.

6245. Sold by G. F. Taylor &. Brush, New York City. Sample sent by W. F. Whitney, Yalesville.

6503. Sold by Taylor & Brush, New York City. Sampled and sent by J. L. Rising, West Suffield.

	Analyses of Dissolved Bone Black.					Analyses of Dissolved Rock Phosphate.					
	5899	6305	6267	5803	5804	6089	6415	6428	5909	6245	6503
Soluble Phosphoric Acid........	19.59	13.94	9.45	16.70	15.89	11.55	8.50	5.46	11.89	13.52	9.78
Reverted " "	.54	1.66	6.80	.18	.28	3.15	4.40	6.23	1.81	1.45	1.63
Insoluble " "	.39	.20	.66	.02	.04	1.39	.88	.44	.77	.38	.60
Total	20.52	15.80	16.91	16.90	16.21	16.09	13.78	12.13	14.47	15.35	12.01
Cost per ton.................	$24.00	20.00	24.00	....	....	20.00	20.00	....	....	....	11.00
"Available" phosphoric acid costs cents per pound.....	5.9	6.5	7.4	....	....	6.6	7.6	....	....	....	4.7

The prices of available phosphoric acid, here given, range from 5.9 to 7.4 cents per pound. In mixed car lots it has been bought for a little over 3 cents per pound.

III. RAW MATERIALS OF HIGH GRADE CONTAINING POTASH.

HIGH GRADE SULPHATE OF POTASH.

This chemical should contain over 90 per cent. of pure potassium sulphate (sulphate of potash) or about fifty per cent. of potassium oxide, the same quantity as is supplied by muriate, and should be nearly free from chlorine.

6336. Sold by Bradley Fertilizer Co., Boston, Mass. Sampled and sent by C. J. Dewey, Buckland.

6032. Sold by L. Sanderson, New Haven.

6096. Sold by Mapes' F. & P. G. Co., Hartford Branch.

5797. Sold by Mapes' F. & P. G. Co. and **5799,** sold by L. Sanderson; both sampled and sent by Harry Manchester, West Winsted.

6218. Bought for use in the Station tobacco experiment.

6031. Bought for use in the Station vegetation experiments.

The analyses are given on page 114.

DOUBLE SULPHATE OF POTASH AND MAGNESIA.

This material is usually sold as "sulphate of potash" or "manure salt," on a guarantee of "48–50 per cent. sulphate," which is equivalent to 25.9–27.0 per cent. of potassium oxide. Besides some 46–50 per cent. of potassium sulphate, it contains over 30 per cent. of magnesium sulphate, chlorine equivalent to 3 per cent. of common salt, a little sodium and calcium sulphates, with varying quantities of moisture.

6301. Sold by the Quinnipiac Co., Boston, Mass., through E. A. Halliday, Suffield.

6033. Sold by L. Sanderson, New Haven.

6264. Sold by E. E. Burwell, Fair Haven.

6095. Sold by Olds & Whipple, Hartford.

6097. Sold by Mapes' F. & P. G. Co., Hartford Branch.

6243. Sold by Taylor & Brush, N. Y. City. Sampled by W. F. Whitney, Yalesville.

6219. Bought for use in the Station tobacco experiment.

Analyses on page 114.

Phosphate of Potash.

6030. A sample of this material, used in the vegetation of experiments of 1896, contained:

Phosphoric Acid	37.48	per cent.
Potash	52.10	"

Muriate of Potash.

Commercial muriate of potash contains about 80 per cent. of muriate of potash (potassium chloride), 15 per cent. or more of common salt (sodium chloride), and 4 per cent. or more of water.

It is generally retailed on a guarantee of 80 per cent. muriate, which is equivalent to 50.5 per cent. of potassium oxide.

6034. Sold by L. Sanderson, New Haven.

6265. Sold by E. E. Burwell, Fair Haven. Sample drawn by him.

6035. Sold by Preston Fertilizer Co., Greenpoint, N. Y., to S. D. Woodruff & Sons, Orange.

6338. Sold by Bradley Fertilizer Co., Boston, to C. J. Dewey, Buckland.

6143. Sold by L. Sanderson, New Haven. Sampled and sent by Chas. B. Sheldon, West Suffield.

6098. Sold by Mapes' F. & P. G. Co., Hartford Branch.

6303. Sold by Quinnipiac Co., Boston, through Olds & Whipple, Hartford.

6302. Sold by Bowker Fertilizer Co., Boston, Mass. Stock of J. E. Collins, Wapping.

Analyses on page 114.

Potash Salts.

6337. Sold by the Bradley Fertilizer Co. to C. J. Dewey, Buckland. Apparently is kainit.

Potash	18.18	per cent.
Cost	$14.00	"
Potash costs, cents per pound	3.9	

The cash retail prices of potash as high grade sulphate have ranged from 4.9 to 5.2 cents per pound; as double sulphate from 4.9 to 6.3 cents; as muriate from 3.9 to 4.4 cents per pound.

	Analyses of High Grade Sulphate of Potash.							Analyses of Double Sulphate of Potash and Magnesia.						
	6336	**6032**	**6096**	**5797**	**5799**	**6218**	**6031**	**6301**	**6033**	**6264**	**6095**	**6097**	**6243**	**6219**
Equivalent Sulphate of Potash	90.5	91.4	91.4	90.8	90.8	90.7	99.5	47.3	51.8	48.1	47.7	46.8	51.8	48.8
Potash	48.89	49.42	49.40	49.10	49.07	48.98	53.79	25.56	28.01	25.98	25.76	25.30	28.00	26.44
Cost per ton	$48.00	50.00	51.00	....	...			25.00	30.00	28.00	32.00	32.00	....	
Potash costs, cents per pound	4.9	5.0	5.2	....	....			4.9	5.3	5.4	6.2	6.3		

Analyses of Muriate of Potash.

	6034	**6265**	**6035**	**6338**	**6143**	**6098**	**6303**	**6302**
Potash	54.13	52.06	52.16	50.38	49.51	51.83	51.78	47.50
Equivalent Muriate of Potash	86.0	82.8	82.9	80.1	78.7	82.4	82.4	75.5
Cost per ton	$42.50	42.00	43.00	42.00	42.50	45.00	45.00	42.00
Potash costs, cents per pound	3.9	4.0	4.1	4.2	4.3	4.3	4.3	4.4

IV. RAW MATERIALS CONTAINING NITROGEN AND PHOSPHORIC ACID.

Bone Manures.

The terms "Bone Dust," "Ground Bone," "Bone Meal" and "Bone" applied to fertilizers, sometimes signify material made from dry, clean and pure bones; in other cases these terms refer to the result of crushing fresh or moist bones which have been thrown out either raw or after cooking, with more or less meat, tendon, and grease and—if taken from garbage or ash heaps—with ashes or soil adhering; again they denote mixtures of bone, blood, meat and other slaughter-house refuse which have been cooked in steam tanks to recover grease, and are then dried and sometimes sold as "tankage;" or finally, they apply to bone from which a large share of the nitrogenous substance has been extracted in the glue manufacture. The nitrogen of all these varieties of bone when they are in the same state of mechanical subdivision has essentially the same fertilizing value.

The method adopted for the valuation of bone manures, which takes account of their mechanical condition as well as chemical composition, is explained on page 98.

1. *Bone Manures Sampled by Station Agents.*

In the following table are given analyses of twenty-two samples of bone drawn by the Station agents. See pages 116 and 117.

The average cost per ton has been $31.18; the average valuation $28.17, showing that the Station schedule of valuations for bone has been somewhat lower than is justified by the average selling price of bone.

Analyses calling for Special Notice.

Mechanical analyses of the three brands of The Rogers & Hubbard Co.'s bone as represented by samples **6120, 6121** and **6122,** having shown the bone to be coarser than in 1895, at request of the manufacturers other samples of each brand, **6332,**

BONE MANURES. SAMPLED BY

Station No.	Name or Brand.	Manufacturer.
6441	Chittenden's Ground Bone.	National Fertilizer Co., Bridgeport.
5894	Ground Bone.	Berkshire Mills, Bridgeport.
6440	Bone Meal.	C. D. Parks, Danbury.
6435	Pure Ground Bone.	Downs & Griffin, Derby.
6090	Bone Meal.	Hartford Fertilizer Co., Hartford.
6443	Self-Recommending Fertilizer.	Frederick Nuhn, Waterbury.
6439	Plumb & Winton's Bone.	Plumb & Winton Co., Bridgeport.
6156	Swift-Sure Bone Meal.	M. L. Shoemaker & Co., Philadelphia, Pa.
6442	Bone Meal.	Milsom Rendering & Fertilizer Co., Buffalo, N. Y.
6437	Ground Bone.	L. B. Darling Fertilizer Co., Pawtucket, R. I.
6154	Pure Bone Meal.	Quinnipiac Co., Boston, Mass.
6436	Ground Bone Meal.	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.
6157	Pure Ground Bone.	Rogers Mfg. Co., Rockfall.
6120	The Rogers & Hubbard Co.'s Raw Knuckle Bone Flour.	The Rogers & Hubbard Co., Middletown.
6122	The Rogers & Hubbard Co.'s Raw Knuckle Bone Meal.	Rogers & Hubbard Co., Middletown.
6121	The Rogers & Hubbard Co.'s Strictly Pure Fine Bone.	Rogers & Hubbard Co., Middletown.
6434	Pure Bone Meal.	Williams & Clark Fertilizer Co., N. Y.
6158	Pure Bone Dust.	Peter Cooper's Glue Factory, N. Y.
6092	Cyclone Bone Meal.	The Milsom Rendering & Fertilizer Co., Buffalo, N. Y.
6438	Pure Ground Bone.	Peck Bros., Northfield.
6155	Fine Ground Bone.	Bradley Fertilizer Co., Boston, Mass.
5895	Ground Bone.	L. Sanderson, New Haven.

STATION AGENT. ANALYSES.

Dealer.	Dealers' cash price per ton.	Valuation per ton.	Percentage Diff. between cost and valuation.	Chemical Analysis.		Mechanical Analysis.			
				Nitrogen.	Phos. Acid.	Finer than 1/50 inch.	From 1/50 to 1/25 inch.	From 1/25 to 1/12 inch.	Coarser than 1/12 inch.
			Valuation exceeds cost.						
H. T. Childs, Woodstock.	***$30.00**	$31.49	4.7	1.80	29.18	74	18	6	2
F. Hallock & Co., Birmingham.	32.00								
Manufacturer.	**30.00**	31.32	4.2	2.00	28.57	72	20	6	2
Raymond Bros., South Norwalk.	**29.00**	30.22	4.0	4.22	20.29	77	20	3	
Manufacturer.	30 00								
Manufacturer.	**30.00**	30.42	1.4	2.44	29.56	48	30	22	
			Cost exceeds valuation.						
Manufacturer.	**25.00**	24.93	.3	3.00	22.64	45	30	13	12
Apothecaries Hall, Waterbury.	**28.00**	27.92	.3	4.16	22.00	58	19	11	12
Manufacturer.	**30.00**	29.40	2.0	4.04	21.81	64	22	13	1
E. A. Buck & Co., Willimantic.	**35.00**	34.24	2.2	5.86	21.88	58	33	9	
W. J. Warner, Gilead.	**30.00**	29.12	3.0	3.61	24.43	56	21	19	4
J. A. Lewis, Willimantic.	**30.00**	28.84	4.0	3.08	23.62	61	29	10	
W. L. L. Spencer, Lebanon.	**30.00**	28.58	4.9	2.94	24.49	58	27	14	1
Olds & Whipple, Hartford.	30.00								
A. C. Middlebrook, No. Wilton.	**36.00**	32.45	10.9	1.60	31.69	73	12	12	3
Manufacturer.	**30.00**	26.75	12.1	4.67	21.35	28	38	34	
Manufacturer.	**37.00**	32.71	13.1	3.66	25.45	62	35	3	
Manufacturer.	**36.00**	31.22	15.3	4.00	24.36	46	47	7	
Manufacturer.	**30.00**	25.50	17.7	3.70	23.62	34	28	27	11
S. A. Flight, New Haven.	**30.00**	25.44	17.9	2.72	22.76	54	21	23	2
Gavet Bros., Westport.	30.00								
E. F. Miller, Ellington.	**30.00**	24.98	20.1	1.51	28.96	54	14	13	9
W. K. Ackley, East Hartford.	**36.00**	27.70	29.9	2.96	24.96	54	23	16	7
W. H. Scott & Co., Terryville.	30.00	19.90	40.7	4.16	20.72	14	22	38	26
Strong & Tanner, Winsted.	32.00								
	28.00								
J. B. Alexander, New Britain.	**33.00**	23.40	41.0	2.97	19.31	44	39	17	
Manufacturer.	**33.00**	23.08	42.9	4.05	26.00	1	33	56	10

* The figures in heavy type, of this column, are used in calculating the percentage difference.

6331 and **6334**, were very carefully drawn at the factory and mechanically analyzed. The result for both years are as follows:

MECHANICAL ANALYSES.

	Raw Knuckle Bone Flour.			Raw Knuckle Bone Meal.			Strictly Pure Fine Bone.		
	1895	1896		1895	1896		1895	1896	
	4774	**6120**	**6332**	**4902**	**6122**	**6331**	**4923**	**6121**	**6334**
Fine, smaller than $\frac{1}{50}$ inch	71	62	53	60	46	50	45	34	28
Fine medium, from $\frac{1}{50}$ to $\frac{1}{25}$ inch,	29	35	45	27	47	38	23	28	25
Medium, from $\frac{1}{25}$ to $\frac{1}{12}$ inch	0	3	2	13	7	12	24	27	31
Coarse, larger than $\frac{1}{12}$ inch	0	0	0	0	0	0	8	11	16
	100	100	100	100	100	100	100	100	100

The samples taken in 1896 are seen to be somewhat coarser than those examined in 1895.

2. *Bone Manures Sampled by Manufacturers and by Private Individuals.*

In the table, page 119, are given analyses of six samples drawn by manufacturers and of thirteen drawn by private individuals.

Sample **6490** was sent to the Station as Electrical Dissolved Bone, with a printed statement guaranteeing only phosphoric acid in the three forms. There is evidently some mistake in the name of the brand, for the sample was clearly a bone meal.

Burned Bone.

6138. Bought of the Rogers Manufacturing Co., Rockfall, Ct., by John B. Smith, Conn. Valley Orchard Co. Sampled by Earl Cooley, Berlin.

The sample was understood to represent ground bone which had been damaged in a fire at the storehouse. It contained .20 per cent. of nitrogen and 40.12 per cent. of phosphoric acid.

The nitrogen and phosphoric acid of bone ash are not readily available as fertilizers till they have been dissolved by an acid.

TANKAGE.

After boiling or steaming meat scrap, bone and other slaughter-house waste, fat rises to the surface and is removed, the soup is run off, and the settlings are dried and sold as tankage. As analyses show, "tankage" has a very variable composition. In general it contains more nitrogen and less phosphoric acid than bone.

BONE MANURES. SAMPLED BY MANUFACTURERS AND PRIVATE INDIVIDUALS.

Station No.	Name or Brand.	Manufacturer or Dealer.	Sampled and Sent by	Dealer's Cash Price per Ton.	Valuation per Ton.	Chemical Analysis.		Mechanical Analysis.			
						Nitrogen.	Phos. Acid.	Less than $\frac{1}{50}$ inch.	From $\frac{1}{50}$ to $\frac{1}{25}$ inch.	From $\frac{1}{25}$ to $\frac{1}{12}$ inch.	Coarser than $\frac{1}{12}$ inch.
6191	Bone.	Elbert Clinton, Clintonville.	Manufacturer.	$26.50	$16.81	4.13	20.93	5	17	31	47
6431	Pure Ground Bone.	Crocker Fertilizer and Chemical Co., Buffalo. N. Y.	Manufacturer.	....	25.84	4.12	25.38	24	19	55	2
6081	Ground Bone.	Downs & Griffin, Derby.	Manufacturer.	....	31.66	2.06	28.68	72	20	7	1
6239	Bone.	August Pouleur, Windsor.	Manufacturer.	....	31.62	2.29	29.77	60	24	15	1
6433	Pure Raw Bone Meal.	Walker, Stratman & Co., Pittsburgh, Pa.	Manufacturer.	....	29.54	3.81	24.50	51	26	22	1
6432	Butcher's Bone Meal.	Walker, Stratman & Co., Pittsburgh, Pa.	Manufacturer.	....	18.09	2.24	13.16	77	16	7	--
6137	Ground Bone.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	Earl Cooley, Berlin.	33.00	29.61	2.56	25 61	61	32	7	--
6105	Bone.	J. G. Jefferds, Worcester, Mass.	Perrin & Calkins, W. Woodstock.	31.00	33.88	2.06	30.27	75	22	3	--
5881	Ground Bone.	J. D. Leach, Willimantic,	C. B. Pomeroy, Jr., Willimantic.	25.00	17.48	4.00	20.33	14	17	21	48
5882	Ground Bone.	J. D. Leach, Willimantic.	C. B Pomeroy, Jr., Willimantic.	25.00	22.39	3.85	21.97	14	31	51	4
6041	Bone Meal.	Monroe, Lalor & Co., Oswego.	Byron Loomis, Suffield.	30.00	28.63	3.92	23.64	54	22	15	9
5269	Fine Ground Bone.	L. Sanderson, New Haven.	F. E. Blakeman, Stratford.	....	20.84	3.18	17.71	37	28	33	2
6141	Fine Ground Bone.	L. Sanderson, New Haven.	Chas. B. Sheldon, W. Suffield.	32.00	26.00	3.66	21.79	44	26	30	--
6342	Ground Bone.	L. Sanderson, New Haven.	Geo. F. Platt & Son, Milford.	....	24.78	3.86	24.42	14	36	49	1
6238	Ground Bone.	Taylor & Brush, New York City.	W. F. Whitney.	....	30.43	2.72	27.63	54	30	15	1
6292	Bone.	Taylor & Brush, New York City.	A. E. Plant, Branford.	....	32.83	3.14	26.14	81	13	5	1
6417	Ground Bone.	Geo. F. Taylor & Brush, N. Y.	H. C. C. Miles, Milford.	24.00	31.45	2.62	27.25	72	17	10	1
6490	Electrical Dissolved Bone.	M. E. Wheeler & Co., Rutland, Vermont.	Chas. Sanford, Roxbury.	....	27.09	2.79	25.77	47	27	16	10
6277	Fine Ground Bone.	Wilcox Fertilizer Works, Mystic.	Lawrence Daly, E. Windsor Hill.	29.00	31.98	2.24	28.63	72	20	6	2

Sampled by Station Agents.

6091. Tankage. Sold by the Quinnipiac Co., Boston, through Olds & Whipple, Hartford.

5897. Blood, Bone and Meat, and **5898,** Pulverized Bone and Meat, both sold by L. Sanderson.

6104. Tankage. Sold by L. B. Darling Fertilizer Co., Pawtucket, R. I. Sample from stock of J. H. Webb, New Haven.

5896. Tankage. Sold by Taylor & Brush, New York City. Sample from stock of S. D. Woodruff & Sons, Orange.

Sampled by Seller.

6266. Dried Blood and Meat. Sold by E. E. Burwell, Fair Haven.

Sampled by Private Parties.

5805. Tankage. Sold by L. B. Darling Fertilizer Co. Sample sent by J. H. Webb.

5883. No. 1 Tankage. Made by J. D. Leech, Willimantic. Sampled and sent by C. B. Pomeroy, Willimantic.

5629. Tankage. Made by Plumb & Winton, Bridgeport. Sampled and sent by S. E. Curtis, Stratford.

5794. Tankage. Sold by L. Sanderson, New Haven. Sampled and sent by J. H. Webb, New Haven.

5795. Tankage. Made by Sperry & Barnes, New Haven. Sampled and sent by J. H. Webb.

6446. Tankage. Sold by Taylor & Brush, New York City. Sampled and sent by H. C. C. Miles, Milford.

The low valuations of samples **5883** and **5795** are due to their coarse mechanical condition.

Dry Ground Fish.

This residue from the manufacture of fish oil is often sprinkled with diluted oil of vitriol, to hinder decay during drying, whereby the fish bones are softened and to some extent dissolved.

6304. Made by Luce Brothers, Niantic.

6087. Made by Geo. W. Miles, Agent, Milford. From stock of Olds & Whipple, Hartford.

6115. Sold by Quinnipiac Co., Boston, through F. S. Bidwell, Windsor Locks.

ANALYSES OF TANKAGE.

Mechanical Analysis.	6091	5897	5898	6104	5896	6266	5805	5883	5629	5794	5795	6446
Fine, smaller than $\frac{1}{50}$ inch	66	45	58	59	69	61	68	10	61	61	35	83
Fine medium, from $\frac{1}{50}$ to $\frac{1}{25}$ inch	32	37	30	31	28	19	22	17	24	23	17	15
Medium, from $\frac{1}{25}$ to $\frac{1}{12}$ inch	2	14	12	9	3	16	10	28	14	13	27	2
Coarse, larger than $\frac{1}{12}$ inch	0	4	0	1	0	4	0	45	1	3	21	0
	100	100	100	100	100	100	100	100	100	100	100	100
Chemical Analysis.												
Nitrogen	5.65	6.50	5.28	6.22	5.42	7.55	6.08	4.47	5.71	6.70	6.79	4.69
Phosphoric Acid	15.97	12.86	16.75	13.88	16.46	10.46	12.92	8.24	10.08	12.92	9.59	17.28
Cost per ton	$27.00	33.00	36.00	....	....	28.00	....	30.00	25.00	....	....	....
Valuation per ton	$29.40	26.17	27.94	27.92	29.35	27.21	27.18	11.07	22.99	27.69	20.12	28.96

6345. Made by Wilcox Fertilizer Co., Mystic. From stock of John Thompson, Ellington.

6408. Sold by Williams & Clark Fertilizer Co., New York City, through F. C. Gould, Silver Lane.

5796. Made by Geo. W. Miles, Agent, Milford. Sampled by Geo. S. Gillette, Milford.

ANALYSES OF DRY GROUND FISH.

	6304	6087	6115	6345	6408	5796
Nitrogen as nitrates	....	.72	....	....	....	....
as ammonia	1.45	1.08	.42	.10	.50	1.02
organic	7.06	5.76	9.00	8.98	7.57	7.18*
Total nitrogen	8.51	7.56	9.42	9.08	8.07	8.20
Soluble phosphoric acid	.94	1.14	.86	.67	.58	1.13
Reverted phosphoric acid	5.41	5.20	3.39	5.03	8.19	4.72
Insoluble phosphoric acid	.23	.88	2.45	1.31	.91	.82
Total phosphoric acid	6.58	7.22	6.70	7.01	9.68	6.67
Cost per ton	$26.00	32.00	32.00	32.00	30.00	32.00
Valuation per ton	$30.65	28.11	31.78	31.73	31.89	29.45

* Includes some nitrate nitrogen.

MIXED FERTILIZERS.

BONE AND POTASH.

6192. Square Brand Bone and Potash, made by the Bowker Fertilizer Co., Boston, Mass. Stock of C. T. Leonard, Norwich, $29.00 per ton, and P. L. Lathrop, Coventry, $28.00 per ton.

6193. Bone and Potash, made by E. Frank Coe, N. Y. Sampled from stock of H. B. Sherwood, Southport, $26.00 per ton, and J. A. Isham, Columbia, $29.00 per ton.

6145. Dissolved Bone and Potash, made by The Milsom Rendering and Fertilizer Co., Buffalo, N. Y. Sampled from stock of G. M. Cox, Vernon, $30.00 per ton.

MECHANICAL ANALYSES OF BONE AND POTASH.

	6192	6193	6145
Fine, smaller than $\frac{1}{50}$ inch	64	62	....
Fine medium, from $\frac{1}{50}$ to $\frac{1}{25}$ inch	24	22	....
Medium, from $\frac{1}{25}$ to $\frac{1}{12}$ "	10	12	....
Coarse, larger than $\frac{1}{12}$ "	2	4	....
	100	100	100

CHEMICAL ANALYSES OF BONE AND POTASH.

Organic Nitrogen	1.71	2.10	....
Soluble Phosphoric Acid	....	....	6.67
Reverted " "	....	....	2.07
Insoluble " "	....	....	.22
Total " "	13.50	15.79	8 96
Potash	2.30	2.90	2.05*
Cost per ton	$29.00	26.00	30.00
Valuation per ton	$18.36	21.51	11.44

* Partly as sulphate.

No. **6145.** Contains no nitrogen, and is a mixture of acid phosphate and potash salts, but not "bone and potash" in the usually accepted meaning of the term.

NITROGENOUS SUPERPHOSPHATES AND GUANOS.

Here are included those mixed fertilizers containing nitrogen, phosphoric acid and in most cases potash, which are not designed by their manufacturers for use on any special crop. "Special Manures" are noticed further on.

1. *Samples drawn by Station Agents.*

In the tables on pages 128 to 137 are tabulated the analyses of eighty-seven brands, made on samples collected by the Station agents.

GUARANTEES.

Of the eighty-eight analyses of nitrogenous superphosphates, given in the tables, twenty-seven are below the maker's minimum guarantee in respect of one ingredient and five in respect of two ingredients.

Thus thirty-six per cent., or more than one-third of these fertilizers, do not fulfil the manufacturers' guarantees.

In twenty-five cases the deficiency is in potash, and numerous protests have been made by manufacturers who claimed that their goods were mixed to contain decidedly more potash than was shown by the Station analysis. In every case the Station has repeated the potash determination in response to the protest, in many cases has drawn other samples of the same brand for analysis, has referred some samples to other chemists, and has most carefully tested and demonstrated the accuracy of our methods of analysis. In no instance has any error been found in the results first reported.

The following analyses, we are advised by the manufacturers, show less potash than the goods were believed to contain. The special cases are here given in detail to indicate the care which the Station exercises in doing the work of fertilizer analysis which is required by law.

6320. Great Planet A brand and **6322,** King Philip Alkaline Guano, both made by the Clark's Cove Fertilizer Co. On receiving the protest of the manufacturer a re-test of potash was made in each sample, which confirmed the test already reported.

6326. General Crop Phosphate, made by the Crocker Fertilizer Co., Buffalo. Repetition of the potash determination confirmed the result previously reported.

6380. Cumberland Concentrated Phosphate, made by the Cumberland Bone Fertilizer Co., Boston. The manufacturers called for a portion of our sample, in which their chemist found 8.27 per cent. of potash, while the figure reported by the Station was 6.22. Careful repetition of our determination gave 6.24 per cent. The amount guaranteed was 7 per cent.

6359. Chittenden's Complete Fertilizer, sold by the National Fertilizer Co., Bridgeport. This sample was a mixture of equal weights of eight samples drawn in various places. The per cent. of potash found was 4.82.

The manufacturer protested that the per cent. of potash found was not only below their guarantee, but below the calculated composition of the goods, and below what had been found by their chemist in samples of the product of each day's manufacture at the works.

A re-test of the sample with specially prepared reagents gave 4.90 per cent. A portion of the same sample was sent to the chemist of the company, by request, who reported 5.48 per cent.

At the same time, for another purpose, the reagents and method of potash determination used in the Station laboratory were subjected by Mr. Winton to a thorough re-examination with the result that potash was determined with uniform accuracy, both in pure salts and in mixtures containing all the impurities found in commercial fertilizers, the total error being less than 0.3 per cent. of the quantity of potash present; *i. e.* in a mixture containing 5.00 per cent. of potash, repeated analyses would show figures ranging from 4.985 to 5.015 per cent.

Potash was next separately determined in each of the eight samples from which No. **6359** had been prepared, with the following results, 4.47, 5.45, 3.49, 5.46, 5.14, 4.01, 3.76, 5.79.

These determinations show the range of composition observed in different lots of the same brand; the average, 4.74, is nearly the same figure which was first obtained by analysis of the mixture No. **6359**.

A new mixture was then made of equal weights of these eight samples and analyzed by this Station. It was also divided with the greatest care into five portions, which were sent to the laboratories of two Agricultural Stations, to two commercial chemists, and to the chemist of a fertilizer works, requesting in each case a determination of the potash soluble in water. No explanation regarding the sample was given. Following are the reports received:

	Average.
Station I, Chemist A, 4.83, 4.89, 4.89	4.87
" B, 5.00, 4.90	4.95
" C, 5.01	5.01
Average of all determinations	**4.92**
Station II, 4.89, 4.90	**4.90**
This Station, 4.78, 4.80, 4.87, 4.80, 4.74, 4.88, 4.81*	**4.81**
Chemist of Fertilizer Works	**4.89**
Commercial Chemist A	**5.11**
" " B	**5.26**

* One or more determinations in each of the five samples.

A sample of the same brand, No. **6492**, drawn by our agent at the company's works in Bridgeport, from a stock of 20 tons, the full analysis of which appears in the table, page 133, contained considerably more potash, 5.46 per cent.

In sample No. **6363**, Chittenden's Ammoniated Bone Superphosphate, the manufacturers claim more than two per cent. of potash. This Station found 1.91. Small samples were sent by us at request of the manufacturer to two commercial chemists, who found 2.41 and 2.45 per cent. respectively.

6289. Soluble Pacific Guano, made by the Pacific Guano Co., Boston, Mass. This sample is guaranteed to contain over 2 per cent. of potash. Our analysis showed but 1.9, which was objected to by the manufacturer.

As the same brand contained, however, two per cent. more of available phosphoric acid than the guarantee, it is likely that some inequality in mixing accounts for both discrepancies.

6386. High Grade General Fertilizer, made by the Pacific Guano Co., Boston.

6.16 per cent. of potash was found by the Station analysis. The manufacturer asked for a portion of the sample, and in this their chemist reported 8.25 per cent. A re-test made at this Station showed 6.07 per cent. The manufacturers reported that on receipt of the second test they referred their sample to a commercial chemist, who found 8.45 per cent.

The whole remaining original sample was then finely pulverized and divided into three portions. One of these was sent to another Station laboratory, and the second to a commercial chemist, with the request to determine potash soluble in water. The results reported were:

		Average.
Commercial Chemist		6.35
Station Chemist A, 5.89	Average	5.92
" " B, 5.99		
" " C, 5.80		
Conn. Station, 5.70, 5.80, 5.77		5.78

Messrs. M. L. Shoemaker & Co., manufacturers of No. **6251**, Swift Sure Superphosphate, protested that no chlorides were used in the manufacture of their goods, and that the amount of chlorine found, 1.87 per cent., was inexplicable except by error in the determination. The analysis was repeated with the same result.

Another sample of Swift Sure Superphosphate, No. **6456**, was sent by F. Ellsworth, of Hartford, with request for a chlorine determination.

Our analysis showed .59 per cent. This determination was unsatisfactory to the manufacturer, who requested us to send samples to two commercial chemists, each of whom reported only a trace. After correspondence, one of them repeated the test with certain precautions which we had found necessary and then reported .53 per cent., substantially the same percentage as we at first reported.

6360. Royal Bone Phosphate, made by the Williams & Clark Fertilizer Co., N. Y., was found by our analysis to contain 1.90 per cent. of potash.

The manufacturer protested that this figure did not represent the average composition of the goods, but a re-test confirmed the accuracy of the test first reported.

Analysis No. **6384** is of a sample drawn by our agent from stock of L. H. Grant, Broadbrook, that purported to be Ceres Complete Fertilizer, made by George W. Miles, Agent, Milford. The analysis of this fertilizer is as follows:

Nitrogen as nitrates	.29
Nitrogen as ammonia	.56
Nitrogen, organic	2.14
Total nitrogen	2.99
Soluble phosphoric acid	5.10
Reverted " "	2.22
Insoluble " "	2.21
Total " "	9.53
Potash as muriate	2.44
Total potash	4.86
Cost	$38.00
Valuation	21.78

The manufacturer protests that this analysis does not at all correspond with the guaranteed composition of the Ceres brand, the widest discrepancy being in the potash, of which ingredient 7 per cent. is guaranteed, and that so far as the nitrogen and phosphoric acid are concerned, it corresponds very closely with the composition of the IXL Ammoniated Superphosphate, made by him, which is given in the table, page 128, Analysis No. **6167**.

As the manufacturer's protest did not reach the Station till these pages were ready for the printer, it has not been possible to secure and analyze another sample of the Ceres brand.

Cost and Valuation.

Cost.

The method used to ascertain the retail cost price of the superphosphates is as follows:

The sampling agents inquire and note the price at the time each sample is drawn. The analysis, when done, is reported to each dealer from whom a sample was taken, with an enclosed postal card addressed to the Station, and a request to note on it whether the retail cash price is correctly given and to mail to the Station.

From the data thus obtained the average prices are computed.

Nitrogenous Superphosphates and Guanos, Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers Cash Price per Ton.
6414	Carteret Manure for general use.	Eastern Farm Supply Association, Montclair, N. J.	F. S. Bidwell, Windsor Locks.	$29.00
6197	Bone, Fish and Potash.	E. R. Kelsey, Branford.	J. E. Wooding, New Haven.	20.00
			Wilson & Burr, Middletown.	26.00
				23.00
6088	Pure Fine Bone Dissolved in Sulphuric Acid.	Mapes' Formula and Peruvian Guano Co., N. Y. City.	Mapes' Branch, Hartford.	30.00
6406	Unexcelled Phosphate.	Geo. W. Miller, Middlefield.	Manufacturer.	30.00
6389	Fish and Potash, Pequot Brand.	Quinnipiac Co., Boston, Mass.	A. I. Martin, Wallingford.	22.00
6228	Harvest Home Phosphate.	H. J. Baker & Bro., N. Y. City.	Webster & Atwater, New Britain.	27.00
			Wm. G. Humphrey, Canton Center.	27.50
6230	Lowell Bone Fertilizer.	Lowell Fertilizer Co., Lowell, Mass.	Bugbee Bros., Willimantic.	27.00
			W. H. Anderson, Putnam.	30.00
6252	Essex XXX Fish and Potash.	Russia Cement Co., Gloucester, Mass.	J. A. Lewis, Willimantic.	28.00
6282	Animal Fertilizer, G. Brand.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	J. H. Lynch, Ellington.	28.00
			F. S. Bidwell, Windsor Locks.	30.00
				29.00
6226	Quinnipiac Market Garden Manure.	Quinnipiac Co., Boston, Mass.	L. A. Grannis, Fair Haven.	35.00
			C. H. Banks, Greenfield Hill.	35.00
			F. S. Bidwell, Windsor Locks.	38.00
			Olds & Whipple, Hartford.	38.00
6367	Ammoniated Bone Superphosphate.	Preston Fertilizer Co., Greenpoint, L. I.	Calvin G. Wilcox, Merrow.	30.00
			Newell St. John, Simsbury.	30.00
6371	Old Reliable Superphosphate.	L. Sanderson, New Haven.	Manufacturer.	30.00
6395	Complete Bone Superphosphate.	Wilcox Fertilizer Works, Mystic.	Browning & Gallup, New London.	29.00
6203	Gardeners' Complete Manure.	Packers' Union Fertilizer Co., N. Y. City.	W. H. Terry, Willimantic.	34.00
6392	Ammoniated Dissolved Bone.	Quinnipiac Co., Boston, Mass.	Gault Bros., Westport.	28.00
6386	High Grade General Fertilizer.	Pacific Guano Co., Boston, Mass.	J. A. Paine, Danielson.	34.00
6167	IXL Ammoniated Bone Superphosphate.	George W. Miles, Milford.	H. B. Sherwood, Southport.	26.00
6251	Swift Sure Superphosphate.	M. L. Shoemaker & Co., Philadelphia, Pa.	L. S. Ellsworth, Simsbury.	....
			E. A. Buck & Co., Willimantic.	35.00
			F. Ellsworth, Hartford.	36.00
5893	Complete Fertilizer.	Berkshire Mills, Bridgeport.	Manufacturer.	35.00
6376	Garden Special.	Great Eastern Fertilizer Co., Rutland, Vt.	J. G. Schwink, Meriden.	35.00
6394	High Grade Fish and Potash.	Wilcox Fertilizer Works, Mystic.	Browning & Gallup, New London.	30.00

Analyses.

Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen. Nitrogen as Nitrates.	Nitrogen. Nitrogen as Ammonia.	Nitrogen. Nitrogen, Organic.	Nitrogen. Total Nitrogen. Found.	Nitrogen. Total Nitrogen. Guaranteed.	Phosphoric Acid. Soluble.	Phosphoric Acid. Reverted.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Total. Found.	Phosphoric Acid. Total. Guaranteed.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Potash. Found. As Muriate.	Potash. Found. Total.	Potash. Guaranteed.
$25.52	13.6	.59	.46	2.51	3.56	*2.5*	4.16	5.45	.62	10.23	....	9.61	*8.0*	5.82	5.82	*5.0*
20.19	13.9	....	.86	3.04	3.90	*3.3*	2.64	2.47	.14	5.25	*4.0*	5.11	....	.37	3.71	*4.0*
25.82	16.2	....	....	2.18	2.18	*2.1*	7.48	10.75	.92	19.15	....	18.23	*12.0*	.....	.....	....
25.72	16.6	....	....	2.00	2.00	*1.5*	4.06	6.86	1.30	12.22	*11.5*	10.92	....	9.19	9.19	*8.0*
18.22	20.7	.62	.23	1.72	2.57	*2.5*	3.15	4.47	1.94	9.56	*7.0*	7.62	*6.0*	.80	2.40	*2.0*
21.76	24.0	2.89	.30	.76	3.95	*1.0*	3.40	4.38	1.32	9.10	*9.0*	7.78	*8.0*	2.53	2.53	*2.0*
21.76	24.0	....	....	2.66	2.66	*2.5*	4.22	6.27	.42	10.91	*6.0*	10.49	*5.0*	3.59	3.59	*3.0*
22.34	25.3	....	....	2.37	2.37	*2.1*	4.13	7.38	3.75	15.26	*12.0*	11.51	*10.0*	2.53	2.53	*2.2*
23.09	25.6	....	....	....	2.40	*2.1*	5.09	5.78	1.28	12.15	*7.0*	10.87	*6.0*	4.98	4.98	*4.0*
27.24	28.5	1.21	.50	2.01	3.72	*3.3*	5.07	4.29	1.22	10.58	*9.0*	9.36	*8.0*	7.20	7.20	*7.0*
23.29	28.8	....	....	2.57	2.57	*2.5*	5.37	6.77	2.39	14.53	....	12.14	*9.0*	.63	2.53	*2.0*
23.13	29.7	.11	.22	2.63	2.96	*1.7*	6.77	4.39	.85	12.01	*10.0*	11.16	*7.0*	2.92	2.92	*2.0*
22.21	30.6	....	....	2.54	2.54	*2.1*	6.00	5.08	.77	11.85	*9.0*	11.08	*8.0*	3.45	3.45	*3.0*
25.93	31.1	1.05	....	1.67	2.72	*2.5*	6.38	1.29	.65	8.32	*10.0*	7.67	*8.0*	10.93	10.93	*10.0*
21.36	31.1	.14	....	2.34	2.48	*1.7*	4.74	5.67	1.64	12.05	*10.0*	10.41	*9.0*	3.21	3.21	*2.0*
*25.91	31.2	1.42	....	2.14	3.56	*3.3*	5.02	4.63	.99	10.64	*10.0*	9.65	....	6.16	6.16	*7.0*
19.64	32.4	....	.90	2.14	3.04	*2.8*	4.96	1.68	2.85	9.49	....	6.64	*8.0*	2.97	2.97	*2.0*
*26.37	32.8	.86	....	2.20	3.06	*2.5*	7.30	4.45	1.73	13.48	....	11.75	*9.0*	2.49	4.97	*4.0*
26.00	34.6	.59	....	2.22	2.81	*2.5*	6.75	3.12	1.62	11.49	*10.0*	9.87	*8.0*	.21	6.83	*6.0*
25.69	36.2	.46	....	2.78	3.24	*3.3*	5.38	2.27	.82	8.47	....	7.65	*6.0*	9.05	9.05	*8.0*
21.91	36.9	....	....	3.68	3.68	*3.3*	3.15	3.34	.41	6.90	*6.0*	6.49	*5.0*	5.16	5.16	*4.0*

* See page 128.

Nitrogenous Superphosphates and Guanos, Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.
6396	Ammoniated Bone Phosphate.	Wilcox Fertilizer Works, Mystic.	Browning & Gallup, New London.	$31.00
6318	Complete Manure A. Brand.	Mapes' F. & P. G. Co., N. Y City.	Mapes' Branch, Hartford.	34.00
6174	High Grade Universal Fertilizer.	Packer's Fertilizer Co., N. Y. City.	W. H. Terry, Willimantic. Thos McClimon, Greenville. Nathan S. Bushnell, Taftville.	25.00 26.00 26.00
6308	Animal Fertilizer.	L. B. Darling Fertilizer Co., Pawtucket. R. I.	F. S. Bidwell, Windsor Locks.	34.60
6194	Formula A.	L. Sanderson, New Haven.	L. A. Granniss Fair Haven.	35.00
6377	Superior Truck Fertilizer.	M. E. Wheeler & Co., Rutland, Vt.	E. A. Hoyt, Ridgefield.	36.00
6325	Standard Pure Bone Superphosphate.	Lister's Agricultural Chemical Works. Newark, N. J.	Albertus N. Clark, Milford.	30.00
6183	Market Garden Manure.	Bowker Fertilizer Co., Boston, Mass.	Browning & Gallup, New London. C. T. Leonard, Norwalk.	38.00 40.00
6165	Complete Fertilizer.	Rogers Mfg Co., Rockfall.	Manufacturer.	32.00
6314	Complete Manure for Light Soils.	Mapes' F. & P. G. Co., N. Y. City.	Mapes' Branch, Hartford.	41.00
6355	Giant's Neck Superphosphate.	Luce Bros., Niantic.	Manufacturer.	30.00
6327	Success Fertilizer.	Lister's Agricultural Chemical Works. Newark. N. J.	Albertus N. Clark, Milford.	26.00
6320	Great Planet A.	Clark's Cove Fertilizer Co., Boston, Mass.	John Dolbear, Poquetanuck. W. H, Phillips, Chaplain.	37.00 40.00
6380	Cumberland Concentrated Phosphate.	Cumberland Bone Fertilizer Co., Boston. Mass.	A. J. Palmer, Branford.	38.00
6207	Vegetable Bone Phosphate.	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	F. B. Newton, Plainville. Orlando Jones, Highwood.	40.00 43.00
6361	Formula A.	L. Sanderson, New Haven.	Joseph Pierpont, North Haven. E. B. Clark & Sons, Milford. S A. Chalker, Saybrook.	34.00 35.00 35.00
6381	Complete Manure for General Use	Mapes' F. & P. G. Co., N. Y. City.	Mapes' Branch, Hartford.	37.00
6369	Gold Brand Excelsior Guano.	E. Frank Coe Co., N. Y. City.	J. A. Isham, Columbia. Walkley & Damery, Wethersfield	34.50 37.00 35.00
6229	A. A. Ammoniated Bone Superphosphate.	H. J. Baker & Bro., N. Y. City.	Strong & Tanner, Winsted. Webster & Atwater, New Britain.	35.00 37.50
6362	Chittenden's Market Garden Manure.	National Fertilizer Co., Bridgeport.	G. A. & H. B. Williams, Silver Lane. D. N. Benton, Guilford.	33.00 33.00
6257	Hill and Drill Phosphate.	Bowker Fertilizer Co., Boston, Mass.	P. L. Lathrop, Coventry. H. B. Coger, Hawleyville.	35.00 36 00 33.00

ANALYSES.—*Continued.*

Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
					Total Nitrogen.					Total.		Available.		Found.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	Guaranteed.
$22.57	37.4	....	.55	2.73	3.28	*2.5*	1.65	5.92	1.79	9.36	*7.0*	7.57	*6 0*	5.36	5 36	*5.0*
24.73	37.5	.73	1.84	.38	2.95	*2 5*	7.68	4.80	.53	13 01	*12.0*	12.48	*10.0*	2 97	3.02	*2.5*
18.89	37.6	trace	....	1.49	1.49	*.8*	7.12	1.96	.89	9.97	....	9.08	*8.0*	5.08	5.08	*5.0*
24.69	37.7	....	.55	3.37	3.92	*3.3*	1.55	5.73	1.59	8.87	*10.0*	7.28	*6.0*	5.42	5.42	*4.0*
25.32	38.2	.53	.28	2.44	3.25	*3.3*	6 86	3.43	1.25	11.54	*10.0*	10.29	....	5.27	5.27	*6.0*
25.95	38.7	.78	....	2.72	3.50	*3.3*	5.97	2.37	.62	8.96	....	8.34	*7.0*	7.81	7.81	*8.0*
21.53	39 3	....	.44	2.05	2.49	*2.3*	9.38	1.68	2.04	13.10	....	11.06	*10.0*	1.83	1.83	*1.5*
27.17	39.9	1.25	....	1 45	2.70	*2.5*	6.32	2.75	3.35	12.42	*8.0*	9.07	*6.0*	9.65	9.65	*10.0*
22.62	41.5	.77	....	1.63	2.40	*2 2*	5.95	5 05	1.08	12.08	*10 0*	11.0	....	4.39	4.39	*5.0*
28.91	41.8	1.02	.65	3.26	4.93	*4.9*	4.05	4.28	.94	9.27	*8.0*	8.33	*6.0*	6.62	6.62	*6.0*
21.08	42.3	....	.62	2.56	3.18	*3.3*	4.64	1.12	.10	5.86	*5.0*	5.76	....	.25	5.81	*5.0*
18.24	42.5	....	....	1.47	1.47	*1.2*	8.98	1.80	2.10	12.88	....	10.78	*9.5*	.74	1.67	*2.0*
*25.96	42.6	1.75	....	1.84	3 59	*2.9*	4.77	4.27	.89	9.93	....	9.04	*8.0*	6.89	6.89	*7.0*
*26.48	43.5	1.23	....	2.31	3.54	*3 3*	5.15	5.02	1.00	11.17	*10.0*	10.17	*8.0*	6.22	6 22	*7.0*
27.85	43.6	....	....	5.24	5.24	*4.9*	5.71	.93	.40	7.04	....	6.64	*6.0*	6.46	6.46	*5.0*
24.30	44.0	1.04	.27	1.93	3.24	*3.3*	4.66	3.65	.76	9.07	*10.0*	8.31	*8.0*	4.08	6.61	*6.0*
25.39	45.7	.76	.32	2.52	3.60	*3.3*	3.04	7.29	.74	11.07	*10.0*	10.33	*8.0*	4.88	4.88	*4.0*
23.84	46.8	....	.85	1.79	2.64	*2.5*	7.68	1.44	.78	9.90	....	9.12	*8.0*	.53	6.13	*6.0*
23.69	47.7	.40	1.42	1.26	3.08	*2.5*	9.49	1.47	.39	11.35	....	10.96	*10.0*	3.06	3.06	*2.0*
22.10	49.3	....	....	2.40	2.40	*2.5*	1.01	7.93	1.78	10.72	*8.0*	8.94	*7.0*	6.26	6.26	*6.0*
22.07	49.5	.84	....	1.84	2 68	*2.5*	8.00	3.17	1.41	12.58	*12.0*	11.17	*9.0*	2.36	2.36	*2.0*

* See page 124.

NITROGENOUS SUPERPHOSPHATES AND GUANOS, SAMPLED BY THE STATION.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.
6365	Standard Complete Manure.	Standard Fertilizer Co., Boston, Mass.	Nathan S. Bushnell, Taftville.	$38.00
			A. L. Kuren, Tolland.	40.00
6366	Chittenden's Fish and Potash.	National Fertilizer Co., Bridgeport.	G. A. & H. B. Williams, Silver Lane.	30.00
			T. H. Eldridge, Norwich.	32.00
5892	Ammoniated Bone Phosphate.	Berkshire Mills, Bridgeport.	Manufacturer.	30.00
6213	Americus Brand Ammoniated Bone Superphosphate.	Williams & Clark Fertilizer Co., N. Y. City.	F. C. Gould, Silver Lane.	33.60
			F. B. Austin, Silver Mine.	33.00
			Edw. L. Strong, Colchester.	34.00
6403	Smoky City Phosphate.	Walker, Stratman & Co., Pittsburgh, Pa.	White and Juno, Rockville.	30.00
6352	Ammoniated Bone Superphosphate.	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Carlos E. Kibbe, Wapping.	33.00
6184	Farmers' New Method Fertilizer.	Bradley Fertilizer Co., Boston, Mass.	D. L. Clark, Milford.	30.00
			J. B. Alexander, New Britain.	33.00
6375	Buffalo Fertilizer.	Milsom Rendering & Fertilizer Co., Buffalo, N. Y.	W. H. Bishop, Andover.	30.00
6212	Quinnipiac Phosphate.	Quinnipiac Co., Boston, Mass.	L. A. Granniss, Fair Haven.	32.00
			F. S. Bidwell, Windsor Locks.	33.00
			A. I. Martin, Wallingford.	34.00
6385	Vegetable Bone Fertilizer.	Milsom Rendering & Fertilizer Co., Buffalo, N. Y.	E. A. Halliday, Suffield.	40.00
6132	O. & W. Special Phosphate.	Olds & Whipple, Hartford.	Manufacturer.	36.00
6492	Chittenden's Complete Fertilizer.	National Fertilizer Co., Bridgeport.	Manufacturer.	38.00
6359	Chittenden's Complete Fertilizer.	National Fertilizer Co., Bridgeport.	E. B. Clark & Sons, Milford.	35.00
			G. A. & H. B. Williams, Silver Lane.	38.00
			H. T. Child, Woodstock.	38.00
			H. J. Humphrey, Simsbury.	40.00
			L. H. Grant, Broad Brook.	40 00
			F. Hallock & Co., Birmingham.	40.00
6196	Patent Superphosphate.	Bradley Fertilizer Co., Boston, Mass.	Raymond Bros., So. Norwalk.	33.00
			F. S. Bidwell, Windsor Locks	34.00
			Manchester Elevator Co., Manchester.	36.00
6349	Nameless Fertilizer.	C. D Parks, Danbury.	Manufacturer.	30.00
6410	Bay State Fertilizer.	Clark's Cove Fertilizer Co., Boston, Mass.	John Ballard, Thompson.	34.00
			H. F. Standish, Andover.	34.00
6398	Fish and Potash.	Williams & Clark Fertilizer Co., N. Y. City.	George H. Sloan, Windsorville.	30.00
6175	High Grade Ammoniated Bone Phosphate.	E. Frank Coe Co., N. Y. City.	J. A. Isham, Columbia.	31.00
			Walkley & Damery, Wethersfield.	33.25
				32.00
6256	Sure Crop Phosphate.	Bowker Fertilizer Co., Boston, Mass.	City Coal and Wood Co., New Britain.	28.00

Analyses.—*Continued.*

Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen.		Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.		Guaranteed.
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	
$25.20	50.8	1.65	....	1.83	3.48	3.3	4.80	4.55	1.26	10.61	9.0	9.35	8.0	5.88	5.88	7.0
19.88	50.9	....	....	2.46	2.46	2.8	1.46	5.70	4.00	11.16	8.0	7.16	....	4.22	4.50	4.0
19.77	51.7	....	....	1.95	1.95	1.7	7.63	3.24	1.62	12.49	10.0	10.87	8.0	2.26	2.26	2.0
21.64	52.5	.29	...	2.38	2.67	2.5	6.40	4.71	1.64	12.75	10.0	11.11	9.0	1.99	1.99	2.0
19.63	52.9	....	....	1.44	1.44	1.2	9.66	3.04	.90	13.60	15.0	12.70	12.0	1.74	1.74	2.0
21.48	53.6	....	....	2.74	2.74	2.9	9.34	2.02	.49	11.85	....	11.36	10.0	1.47	1.47	1.1
19.53	53.6	.27	....	1.85	2.12	1.7	5.60	4.16	1.37	11.13	10.0	9.76	8.0	3.06	3.06	3.0
19.44	54.3	....	....	2.76	2.76	1.9	7.30	2.06	.50	9.86	....	9.36	8.0	.65	1.48	1.5
21.33	54.7	.32	....	2.34	2.66	2.5	6.56	4.40	1.32	12.28	10.0	10.96	9.0	1.97	1.97	2.0
25.77	55.2	....	....	3.80	3.80	4.1	8.35	1.39	.37	10.11	9.0	9.74	8.0	4.89	4.89	5.0
22.92	57.0	.75	....	2.65	3.40	2.5	6.38	3.50	1.38	11.26	10.0	9.88	9.0	.72	2.47	2.0
*21.01	58.3	.56	.48	2.33	3.37	3.3	3.70	5.34	.55	9.59	10.0	9.04	8.0	5.46	5.46	6.0
†23.89	59.0	.46	.55	2.22	3.23	3.3	3.55	6.25	.69	10.49	10.0	9.80	8.0	4.82	4.82	6.0
21.30	59.6	.33	....	2.47	2.80	2.5	6.72	3.91	1.22	11.85	11.0	10.63	9.0	1.89	1.89	2.0
18.75	60.0	.23	....	2.31	2.54	2.1	.40	6.92	1.17	8.49	8.0	7.32	....	4.26	4.26	3.0
21.10	61.1	.27	....	2.39	2.66	2.5	6.24	4.72	1.00	11.96	10.0	10.96	9.0	1.89	1.89	2.0
18.55	61.7	....	.20	2.16	2.36	2.1	2.78	5.31	1.16	9.25	6.0	8.09	4.0	3.41	3.41	4.0
19.77	61.8	....	....	2.22	2.22	2.1	7.66	2.38	2.25	12.29	11.0	10.04	9.0	.33	1.87	1.8
17.09	63.8	.29	....	.94	1.23	.8	7.29	3.39	2.70	13.38	10.0	10.68	8.0	1.32	1.32	1.0

* See p. 125.

† See p. 124.

Nitrogenous Superphosphates and Guanos, Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.
6105	Fish and Potash, A Brand.	Bradley Fertilizer Co., Boston, Mass.	Billings & Hallock, Meriden.	$33.00
6398	Standard Fertilizer.	Standard Fertilizer Co., Boston, Mass	Nathan S. Bushnell, Taftville.	32.00
6379	Big Bonanza, Welcome Brand.	Walker Stratman & Co., Pittsburgh.	J. W. Euerle, Stratford.	33.00
6260	Sea Fowl Guano.	Bradley Fertilizer Co., Boston, Mass.	F. S. Bidwell, Windsor Locks.	32.00
6311	Cumberland Superphosphate.	Cumberland Bone Phosphate Co., Boston, Mass.	William Bartell, Ore Hill.	32.00
6211	Fish, Bone and Potash.	Read Fertilizer Co., N. Y.	L. D. Post, Andover.	30.00
			J. A. Silliman, New Canaan.	30.00
6350	Animal Bone and Potash.	Lister Agricultural Chemical Works, Newark, N. J.	Edward Hall, Plainfield.	28.00
6363	Chittenden's Ammoniated Bone Phosphate.	National Fertilizer Co., Bridgeport.	E. B. Clark & Sons, Milford.	26.00
			L. H. Grant, Broad Brook.	30.00
			T. H. Eldridge, Norwich.	32.00
			Horace Humphrey, Simsbury.	32.00
6321	Bay State Fertilizer G. G.	Clark's Cove Fertilizer Co., Boston, Mass.	W. H. Phillips, Chaplin.	33.00
			J. M. Burke, South Manchester.	34.00
6279	Soluble Bone and Potash.	Great Eastern Fertilizer Co., Rutland, Vt.	William L. Baxter, New Canaan.	26.00
			F. V. Cantrell, Darien	26.00
			Thomas Richmond, New Milford.	34.00
6180	Standard Superphosphate.	Read Fertilizer Co., New York.	John R. Babcock, Mystic.	29.00
			L. D. Post, Andover.	30.00
6322	King Philip Alkaline Guano.	Clark's Cove Fertilizer Co., Boston, Mass.	J. M. Burke, South Manchester.	28.00
6289	Soluble Pacific Guano.	Pacific Guano Co., Boston, Mass.	E. A. Burnham, Andover.	34.00
			George Webster, Rockville	35.00
			Saxton & Strong, Bristol.	35.00
			John A. Paine, Danielson.	36.00
6326	General Crop Phosphate.	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Bugbee Bros., Willimantic.	23.00
6374	Cumberland Fertilizer.	Cumberland Bone Phosphate Co., Boston, Mass.	A. J. Palmer.	28.00
6255	Farm and Garden Phosphate.	Bowker Fertilizer Co., Boston, Mass.	S. E. Brown, Collinsville.	35.00
			C. T. Leonard, Norwalk.	36.00
				32.00
6391	Fish and Potash, Crossed Fishes Brand.	Quinnipiac Co., Boston, Mass.	Olds & Whipple, Hartford	34.00
6360	Royal Bone Phosphate.	Williams & Clark Fertilizer Co., New York City.	J. S. Buell, Madison.	26.00
			E. L. Strong, Colchester.	28.00
			J. H. Avery, Lebanon.	29.00
6205	New Rival Ammoniated Superphosphate.	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Orlando Jones, Highwood.	30.00
			E. A. Davis & Son, Danielson	34.00
			F. B. Newton, Plainville.	34 00
				33.00

ANALYSES.—*Continued.*

Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Total Nitrogen. Found.	Total Nitrogen. Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found. As Muriate.	Found. Total.	Guaranteed.
$19.98	65.2	....	....	2.24	2.24	2.1	5.42	4.17	1.23	10.82	12.0	9.59	8.0	3.43	3.43	4.0
19 12	67.4	....	....	2.16	2.16	2.1	5.33	4.59	1.40	11.32	10.0	9.92	8.0	2.29	2.29	2.0
19.65	67.9	....	....	1.44	1.44	1.7	9.84	3.16	.88	13.88	....	13.00	11.0	1.43	1.43	2.0
19.01	68.3	.35	....	1.83	2.18	2.1	3 84	6.69	1.90	12.43	10.0	10.53	8.0	1.41	1.41	1.5
18.89	69.4	.35	....	1.84	2.19	2.1	5.84	3.97	1.51	11.32	10.0	9.81	8.0	2.00	2.00	2 0
17.54	71.0	....	....	2.88	2.88	2.5	3.50	1.55	.83	5.88	5 0	5.05	4.0	4.17	4.17	4.0
16.33	71.5	....	....	.42	.42	.8	8.10	1.84	.47	10.41	10.0	9.94	9.0	4.57	4 67	5.0
*17.42	72.2	....	....	1.83	1.83	1.7	.59	9.31	1.55	11.45	9.0	9.90	7.0	1.91	1.91	2.0
19.16	72.2	.32	....	1.90	2.22	1.0	6.14	3.68	1.86	11.68	10.0	9.82	8.5	2.01	2.01	2.0
14.93	74.1	....	....	....	....	....	8.32	3.75	.90	12.97	....	12.07	11.0	1.86	1.86	2.0
17.16	74.8	trace	....	1.20	1.20	.8	7.31	1.96	.68	9.95	9.0	9.27	8.0	3.92	3.92	4 0
†15.94	75.6	....	....	1.34	1.34	1.0	4.77	4.66	1.60	11.03	9.0	9.43	8.0	1.82	1.82	2.0
*19.81	76.7	....	....	2.34	2.34	2.1	5.65	4.79	1.34	11.78	10.0	10.44	7.0	1.90	1.90	2.0
†12.91	78.2	....	....	.97	.97	.8	5.39	2.06	3.31	10.76	....	7.45	7.0	.98	.98	1.1
15.67	78.7	....	....	1.16	1.16	1.0	4.94	4.83	1.31	11.08	10.0	9.77	8.0	1.82	1.82	2.0
17.65	79.3	.38	....	1.51	1.89	1.7	3.49	5.22	3.76	12.47	10.0	8.71	8.0	2.26	2.26	2 0
18.84	80.4	....	.34	2.99	3.33	3.3	1.55	4.16	1.76	7.47	5.0	5.71	3.0	.80	2.96	3.0
‡15.36	82.3	....	....	1.15	1.15	1.0	4.40	4.88	1.80	11.08	8.0	9.28	7.0	1.89	1.89	2.0
17.96	83.7	....	....	1.46	1.46	1.2	7.31	2.85	3.22	13.38	....	10.16	10.0	1.88	1.88	1.5

* See pp. 125. † See pp. 124. ‡ See pp. 126.

NITROGENOUS SUPERPHOSPHATES AND GUANOS, SAMPLED BY THE STATION.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.
6324	Fish and Potash.	Berkshire Mills, Bridgeport.	C. H. Youngs & Son, Yalesville.	30.00
			T. H. Eldridge, Norwich.	32.00
			H. R. Hoisington, Jr., Coventry.	32.00
			F. S. Bidwell, Windsor Locks.	34.00
6284	Nobsque Guano.	Pacific Guano Co., Boston, Mass.	Saxton & Strong, Bristol.	30.00
			John A. Paine, Danielson.	32.00
			J. O. Fox & Co., Putnam.	32.00
			Carlos Bradley, Ellington.	27.00
6372	Cleveland Fertilizer.	Cleveland Dryer Co., Boston, Mass.	D. F. Southwick, Putnam.	30.00
6378	Economical Bone Fertilizer.	Wilkinson & Co., N. Y. City.	W. W. Peck, Woodbridge.	32.00
6402	Four Fold Fertilizer.	Walker, Stratman & Co., Pittsburgh.	White & Juno, Rockville.	31.00
6086	Buffalo Guano.	Milsom Rendering and Fertilizer Co., Buffalo, N. Y.	W. K. Ackley, East Hartford.	33.00
6082	Erie King.	Milsom Rendering and Fertilizer Co., Buffalo, N. Y.	W. K. Ackley, East Hartford.	32.00

ANALYSES.—*Continued.*

Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
					Total Nitrogen.					Total.		Available.		Found.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	Guaranteed.
$16.26	84.5	.80	.22	1.73	2.75	*2.5*	1.28	3.04	2.65	6.97	*6.0*	4.32	....	3.43	3.43	*3.0*
15.87	89.0	....	....	1.31	1.31	*1.2*	4.42	4.88	1.54	10 84	*10.0*	9.30	*9.0*	2.04	2.04	*2.0*
15.74	90.6	....	....	1.11	1.11	*1.0*	5.28	4.61	1.11	11.00	*9.0*	9.89	*8.0*	1.97	1.97	*2.0*
16.51	93.8	....	....	1.50	1.50	*1.2*	4.88	3.00	2.21	10.09	....	7.88	*7.0*	3.40	3.40	*3.0*
15.95	94.4	....	....	1.29	1.29	*.8*	6.03	4.28	1.00	11.31	....	10.31	*8.0*	1.14	1.14	*1.0*
16.51	99.9	....	....	1.41	1.41	*.8*	6.74	1.29	1.77	9.80	*9.0*	8.03	*8.0*	1.18	3.27	*4.0*
14.30	123.8	....	....	1.05	1.05	*.8*	6.75	1.35	1.55	9.65	*9.0*	8.10	*7.0*	.71	2.03	*2.0*

Valuation.

The valuation has been computed in all cases in the usual manner as explained on page 98.

Percentage difference given in the table shows the percentage excess of the cost price over the average retail cost of the nitrogen, phosphoric acid and potash contained in the fertilizer.

This information enables the purchaser to estimate the comparative value of different brands and to determine whether it is better economy to buy the commercial mixed fertilizers of which so many are now offered for sale, or to purchase and mix for himself the raw materials. This subject is further discussed on pp. 169 to 176 of this report.

Which plan is preferable can only be determined by each individual farmer, who should know best what his soil and crops need and what his facilities for purchase and payment are.

In case a fertilizer has sold at two or more different prices, the *manufacturer's price*, when known, has been used in calculating percentage difference.

Otherwise an *average, or nearly average price*, forms the basis of comparison between cost and valuation. The price thus employed is printed in heavy-faced type.

The average cost of the nitrogenous superphosphates is $31.56. The average valuation is $21.18, and the percentage difference 49.0.

Last year the corresponding figures were:

Average cost $32.32, average valuation $23.37, percentage difference 38.2.

These valuations, it must be remembered, are based on the assumption that the nitrogen, phosphoric acid and potash in each fertilizer are of good quality and readily available to farm crops. Chemical examination shows conclusively whether this is true in respect of potash and phosphoric acid, but gives little or no clue as to the availability of the organic nitrogen of mixed goods. This Station has been for some years engaged in a study of methods for determining approximately the relative availability of nitrogen, and on subsequent pages is given a report of the work done during the past year on this point.

Since various inferior or agriculturally worthless forms of nitrogen are in the market and are known to be used in compounding fertilizers, and cannot as yet be detected with certainty by analysis,

the only security of purchasers of mixed fertilizers is in dealing with firms which have the highest reputation and are able to satisfy their customers that they use the best raw materials, and in avoiding "cheap" goods offered by irresponsible parties.

2. *Sampled by the Manufacturer.*

In the following table, pages 140, 141, are twelve analyses made on samples deposited with the Director of this Station by manufacturers in compliance with the requirements of the Fertilizer Law.

The brands named were not found in the Connecticut market by our sampling agents.

3. *Sampled by Consumers.*

In the table just referred to are four analyses made on samples of this kind. The Station is not responsible for the accuracy of the sampling, though in each case it holds the written statement of the sampler that the Station's directions for sampling were strictly followed.

NITROGENOUS SUPERPHOSPHATES SAMPLED BY MANUFACTURERS

Station No.	Name or Brand.	Manufacturer.	Dealer or Purchaser.
6420	Eclipse Phosphate.	Bradley Fertilizer Co., Boston, Mass.	....
6421	Bone and Potash, Circle Brand.	Bradley Fertilizer Co., Boston, Mass.	....
6424	Bone and Potash, Anchor Brand.	Bradley Fertilizer Co., Boston, Mass.	....
6425	Practical Ammoniated Superphosphate.	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	....
6476	General Crop Phosphate.	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	....
6418	Fertilizer for Gardens and Lawns.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	....
6452	Lowell Animal Fertilizer.	Lowell Fertilizer Co., Lowell, Mass.	....
6419	Bone, Fish and Potash.	Luce Bros., Niantic.	....
6481	Cereal Fertilizer.	Frederick Ludlam, N. Y. City.	....
6482	Cecrops Fertilizer, Dragon's Tooth Brand.	Frederick Ludlam, N. Y. City.	....
6422	Buffalo Fertilizer, Long Island Brand.	Milsom Rendering & Fertilizer Co., Buffalo, N. Y.	....
6416	Niagara Triumph.	Niagara Fertilizer Works, Buffalo, N. Y.	....
6487	Bowker's Fairfield Fertilizer.	Bowker Fertilizer Co., Boston, Mass.	Simeon Pease, Greenfield Hill.
6040	"All Soluble."		Monroe, Lalor & Co., Oswego, N. Y.
6357	Conn. Valley Orchard Co's Fertilizer.	Quinnipiac Co., Boston, Mass.	Conn. Valley Orchard Co.
6449	"Fertilizer."	Williams & Clark Fertilizer Co., N. Y. City.	E. S. Miner, Burrville.

AND PRIVATE INDIVIDUALS. ANALYSES.

Valuation per Ton.	Nitrogen.					Phosphoric Acid.							Potash.		
	Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen.		Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.		Guaranteed.
				Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	
$20.24	.32	....	1.80	2.12	*1.0*	5.30	6.27	1.66	13.23	*12.0*	11.57	10.0	1.76	1.76	*1.5*
23.38	....	....	1.95	1.95	*1.8*	2.32	10.95	4.42	17.69	*10.0*	13.27	6.0	....	2.65	*2.0*
21.10	....	....	3.72	3.72	*3.3*	3.07	3.61	1.12	7.80	*5.0*	6.68	*3.0*	3.38	3.58	*3.0*
15.62	....	....	1.16	1.16	*.8*	5.62	3.16	4.20	12.98	....	8.78	*8.0*	1.50	1.50	*1.1*
13.14	....	....	1.16	1.16	*.8*	2.83	4.83	2.31	9.97	....	7.66	*7.0*	1.14	1.14	*1.1*
28.32	.75	....	2.93	3.68	*3.3*	3.60	8.44	1.20	13.24	*10.0*	12.04	....	5.79	5.79	*5.0*
29.36	.60	....	3.00	3.60	....	3.30	11.49	1.87	16.66	....	14.79	....	3.86	3.86	....
20.43	....	.86	2.44	3.30	*3.3*	2.35	3.52	.22	6.09	*4.0*	5.87	....	.24	4.84	*4.0*
15.40	.18	....	.77	.95	....	7.05	3.55	1.80	12.40	....	10.60	....	.80	.80	....
24.39	1.35	....	1.93	3.28	....	3.81	3.77	2.35	9.93	....	7.58	....	7.15	7.15	....
20.05	....	....	2.97	2.97	*2.5*	5.97	3.30	.43	9.70	*10.0*	9.27	*8.0*	1.88	1.88	*1.0*
20.35	....	....	2.99	2.99	*2.5*	6.61	2.12	.84	9.57	....	8.73	*8.0*	2.50	2.50	*2.2*
25.89	1.72	....	1.76	3.48	....	5.68	2.87	1.44	9.99	....	8.55	....	7.37	7.37	....
24.89	....	.45	2.65	3.10	....	2.60	6.80	1.63	11.03	....	9.40	....	....	5.81	....
25.58	1.51	....	1.98	3.49	....	6.62	4.42	1.46	12.50	....	11.04	....	4.09	4.09	....
21.81	.78	....	2.08	2.86	....	2.69	4.50	1.74	8.93	....	7.19	....	5.12	6.23	....

Special Manures.

Here are included such mixed fertilizers, chiefly nitrogenous superphosphates, as are claimed by their manufacturers to be specially adapted to the needs of particular crops.

1. *Samples drawn by Station Agents.*

In the tables on pages 144 to 153, are tabulated the analyses of eighty-three brands made on samples drawn by the Station agents.

Guarantees.

Of the eighty-three brands of special manures here tabulated twenty-two are below the manufacturers' guarantee in respect of one ingredient and five in respect of two ingredients, so that nearly one-third of the whole number do not fulfill the manufacturers' claims.

In eighteen cases the deficiency was in potash.

The manufacturers of the following brands expressed disappointment at the low per cent. of potash reported by the Station, and asked for a re-test.

This was made in each case, and in every instance the per cent. of potash found was essentially the same as that found in the first test.

6281. Potato Fertilizer, made by the Bradley Fertilizer Co., Boston. Potash found, 2.95, guaranteed 3.2.

6312. Potato Fertilizer, made by the Cumberland Bone Phosphate Co., Boston. Potash found 2.92 per cent., guaranteed 3.0.

6280. Tobacco Grower, made by the L. B. Darling Fertilizer Co., Pawtucket, R. I. Potash 8.84 per cent., guaranteed 10.8. The manufacturer states that the per cent. of chlorine, 1.47, is also largely in excess of what was expected, as high grade sulphate was used as a source of potash. It was not possible to get other samples of this brand to make a re-test.

6407. Soluble Tobacco Manure, made by the Rogers & Hubbard Co., Middletown. Potash found, 9.40 per cent., guaranteed 10.0. The nitrogen, however, is fully one per cent. above the minimum guarantee.

6163. Tobacco Fertilizer, made by Rogers Manufacturing Co., Rockfall. The analysis showed 4.66 per cent. nitrogen, 6.93 phosphoric acid and 13.47 per cent. potash.

This differed so widely from the guaranteed composition, nitrogen 5.0, phosphoric acid 8.0 and potash 11.0, that the manufacturer asked that another sample be drawn and analyzed.

A Station agent therefore visited the factory and drew sample No. **6335**, page 148, which was found to contain : nitrogen 4.26, phosphoric acid 9.36, and potash 10.31 per cent.

6358. Standard Potato and Tobacco Fertilizer, made by the Standard Fertilizer Co., Boston. Potash found, 2.61 per cent., guaranteed 3.0 per cent.

6477. Potato Phosphate, made by the National Fertilizer Co., Bridgeport. Potash found, 7.28 per cent., guaranteed 8.00.

Cost, Valuation and Percentage Difference.

The average cost of eighty-three Special Manures was $36.19 per ton. The average valuation was $25.64. The difference, $10.55, is equivalent to a "percentage difference" of 41.1.

Last year the corresponding figures were, average cost $37.33, average valuation 27.94, percentage difference 33.6.

2. Special Manures Sampled by Manufacturers.

The following eight analyses were made on samples deposited by the manufacturers at the Station, as required by law.

The sampling agent did not find these brands on sale in the places visited by him.

6423. Special Connecticut Tobacco Manure, made by the Crocker Fertilizer and Chemical Co., Buffalo, N. Y.

6427. Special Potato Fertilizer, made by the Lister Agricultural Chemical Works, Newark, N. J.

6429. Potato Phosphate. **6430.** Tobacco Manure. **6451.** Lawn Dressing, and **6453.** Vegetable and Vine Fertilizer, all made by the Lowell Fertilizer Co., Lowell, Mass.

6426. Potato, Hop and Tobacco Phosphate, Long Island Brand, made by the Milsom Rendering Co., Buffalo, N. Y.

6417. Niagara Wheat and Corn Producer, made by the Niagara Fertilizer Co., Buffalo, N. Y.

Analyses of Special Manures.

	6423	6427	6429	6430	6451	6453	6426	6417
Nitrogen as Nitrates	....	....	1.04	3.60	3.94	.22	....	....
" " Ammonia	....	.26	....	....	....	....	....	....
" Organic	5.50	1.67	2.57	1.84	.31	2.82	2.74	1.78
Total Nitrogen	5.50	1.93	3.61	5.44	4.25	3.04	2.74	1.78
Soluble Phosphoric Acid	5.75	4.48	2 94	4.61	7.23	5.63	6.46	5.86
Reverted " "	1.25	3.91	10.74	5.48	.81	7.97	2.58	2.92
Insoluble " "	.20	2.59	1.34	.44	.07	.20	.36	.84
Total " "	7.20	10.98	15.02	10.53	8.11	13.80	9.40	9.62
Potash as Muriate	.86	2.83	6.39	.29	7.90	7.17	6.97	2.45
Potash as Sulphate	11.08	....	....	7.26	....	....	....	....
Valuation per ton	$34.91	17.89	30.27	33.12	27.41	29.18	23.77	16.90

Special Manures, Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.
6346	Potato Fertilizer.	Chas. E. Lyman, Middlefield.	Manufacturer.	$35.00
6347	Corn Fertilizer.	Chas. E. Lyman, Middlefield.	Manufacturer.	20.00
6383	Manure for Seeding Down.	Mapes' F. & P. G. Co., N. Y. City.	Mapes' Branch, Hartford.	38.00
1 23	The Rogers & Hubbard Co's Fruit Fertilizer.	Rogers & Hubbard Co., Middletown.	Manufacturer.	41.00
6287	Potato and Root Crop Manure.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	J. H. Lynch, Ellington.	34.00
			F. S. Bidwell, Windsor Locks	35.00
6162	Corn Fertilizer.	Rogers Mfg. Co., Rockfall.	Manufacturer.	46.00
6407	The Rogers & Hubbard Co's Soluble Tobacco Manure.	Rogers & Hubbard Co., Middletown.	H. W. Andrews, Wallingford.	42.00
6126	The Rogers & Hubbard Co's Fairchild's Formula for Corn and General Crops.	Rogers & Hubbard Co., Middletown.	Manufacturer.	46.00
6281	Potato Fertilizer.	Bradley Fertilizer Co., Boston, Mass.	D. L. Clark, Milford.	30.00
			John R. Babcock, Mystic.	33.00
6199	Essex Complete Manure for Corn, Grain and Grass.	Russia Cement Co., Gloucester, Mass.	J. A. Lewis, Willimantic.	38.00
			E. N. Pierce & Co., Plainville.	40.00
6161	High Grade Fertilizer for Grass and Grain.	Rogers Mfg. Co., Rockfall.	Manufacturer.	38.00
6323	Potato and Tobacco Fertilizer.	Clark's Cove Fertilizer Co., Boston, Mass.	W. H. Phillips, Chaplain.	33.00
			J. M. Burke, So. Manchester.	36.00
6127	The Rogers & Hubbard Co's Soluble Potato Manure.	Rogers & Hubbard Co., Middletown.	Manufacturer.	38.00
6125	The Rogers & Hubbard Co's Fertilizer for Oats and Top Dressing.	Rogers & Hubbard Co., Middletown.	Manufacturer.	50.00
6198	Essex Complete Manure for Potatoes, Roots and Vegetables.	Russia Cement Co., Gloucester, Mass.	J. A. Lewis, Willimantic.	38.00
			John O. Peckham, Greenville.	38.00
			E. N. Pierce & Co., Plainville.	40.00
6477	Potato Phosphate.	National Fertilizer Co., Bridgeport.	G. A. & H. B. Williams, Silver Lane.	34.00
6164	High Grade Fertilizer for Oats and Top Dressing.	Rogers Mfg. Co., Rockfall.	Manufacturer.	42.00
6124	The Rogers & Hubbard Co's Grass and Grain Fertilizer.	Rogers & Hubbard Co., Middletown.	Manufacturer.	37.50
6285	Potato, Onion and Tobacco Manure.	Wilcox Fertilizer Works, Mystic.	Browning & Gallup, New London.	34.00
			John Thompson, Ellington.	34.00
			C. M. Smith, East Hartford.	37.00
6280	Tobacco Grower.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	J. H. Lynch, Ellington.	38.00
			F. S. Bidwell, Windsor Locks	40.00

ANALYSES.

Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen. Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen. Found.	Total Nitrogen. Guaranteed.	Phosphoric Acid. Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Potash. Found. As Muriate.	Potash. Found. Total.	Potash. Guaranteed.
$25.64	*2.5	....	....	3.38	3.38	*2.5*	3.34	4.47	.84	8.65	*10.0*	7.81	....	8.56	8.56	*10.0*
21.93	*8.8	....	....	....	....	....	9.00	2.75	.31	12.06	*11.0*	11.75	....	10.18	10.18	*10.0*
34.35	10.6	.82	....	2.03	2.85	*2.5*	....	....	....	18.42	*18.0*	....	....	10.83	10.83	*10.0*
36.29	12.9	.15	....	2.91	3.06	*2.5*	....	....	....	19.12	*17.5*	....	....	12.49	12.49	*12.5*
29.38	15.7	....	.35	3.31	3.66	*2.9*	3.04	6.58	2.48	12.10	*10.0*	9.62	*6.0*	5.93	7.75	*7.0*
38.91	18.2	4.60	....	1.66	6.26	*5.4*	...	....	....	12.22	*12.0*	....	....	12.68	12.68	*12.5*
‖35.44	18.5	1.75	.10	3.96	5.81	*4.9*	1.41	8.10	.67	10.18	*10.0*	9.51	....	....	9.40	*10.0*
38.24	20.3	4.05	....	2.07	6.12	*5.5*	....	....	....	12.00	*12.0*	....	....	12.54	12.54	*13.0*
24.79	21.0	.18	....	2.14	2.32	*2.1*	4.90	5.32	1.43	11.65	....	10.22	*9.0*	2.95	2.95	*3.2*
31.37	21.1	.74	....	3.39	4.13	*3.7*	5.18	4.31	1.13	10.62	*10.0*	9.49	*7.5*	10.47	10.47	*9.5*
31.05	22.4	trace	....	3.16	3.16	*3.0*	....	....	....	15.79	*17.0*	....	....	13.73	13.73	*15.0*
26.64	23.9	.23	....	2.18	2.41	*2.1*	5.60	4.84	1.37	11.81	*9.0*	10.44	*8.0*	3.09	3.09	*3.0*
30.56	24.3	1.49	.07	3.32	4.88	*5.0*	1.71	6.75	2.62	11.08	*10.0*	8.46	*7.0*	1.88	6.49	*5.0*
39.87	25.4	7.48	....	1.40	8.88	*9.0*	....	....	....	9.13	*8.0*	....	....	8.77	8.77	*8.5*
30.13	26.1	.60	....	3.47	4.07	*3.7*	4.80	3.90	.93	9.63	*9.0*	8.70	*7.0*	1.20	9.36	*8.5*
‡26.96	26.1	....	....	2.43	2.43	*2.1*	.59	6.58	1.36	8.53	....	7.17	*8.0*	7.28	7.28	*8.0*
33.23	26.4	4.10	....	2.40	6.50	*5.5*	2.72	5.14	.74	8.60	*9.0*	7.86	....	7.79	7.79	*7.5*
29.66	26.4	....	....	2.84	2.84	*2.5*	....	....	....	18.83	*16.5*	....	....	11.55	11.55	*12.5*
26.81	26.8	.83	....	3.01	3.84	*3.3*	4.66	4.26	.67	9.59	*8.0*	8.92	*7.0*	.56	6.54	*6.0*
‖31.47	27.1	....	1.75	3.30	5.05	*4.9*	1.63	5.75	1.88	9.26	*10.0*	7.38	....	1.47	8.84	*10.8*

‖ See p. 142. * Valuation exceeds cost. ‡ See p. 143.

10

SPECIAL MANURES, SAMPLED BY THE STATION.—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.
6388	Quinnipiac Havana Seed Leaf Tobacco Fertilizer.	Quinnipiac Co., Boston, Mass.	Olds & Whipple, Hartford.	$45.00
6253	Complete Onion Manure.	H. J. Baker & Bro., N. Y. City.	C. O. Jelliff & Co., Southport.	38.00
6351	New England Tobacco Grower.	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Carlos E. Kibbe, Wapping.	31.00
6329	Stockbridge Tobacco Manure.	Bowker Fertilizer Co., Boston, Mass.	H. K. Brainard, Thompsonville.	48.00
			L. H. Grant, Broad Brook.	50.00
6387	Potato, Hop and Onion Fertilizer.	Preston Fertilizer Co., Greenpoint, L. I.	E. A. Buck & Co., Willimantic.	32.00
6328	Complete Tobacco Manure.	H. J. Baker & Bro., N. Y. City.	L. J. Grant, Wapping.	40.00
			W. F. Andross, East Hartford.	40.00
6160	High Grade Soluble Potato Manure.	Rogers Mfg. Co., Rockfall.	Manufacturer.	38.00
6445	Complete Manure for Potatoes and Vegetables.	Lowell Fertilizer Co., Lowell, Mass.	J. P. Barstow & Co., Norwich.	35.00
6400	Fine Wrapper Tobacco Grower.	Williams & Clark Fertilizer Co., N. Y. City.	G. H. Clark, Granby.	48.00
6285	High Grade Special.	Williams & Clark Fertilizer Co., N. Y. City.	S. A. Flight, New Haven.	35.00
			Edward L. Strong, Colchester.	36.00
			F. B. Austin, Silver Mine.	38.00
			F. C. Gould, Silver Lane.	39.00
			Greenwoods Co., New Hartford.	38.00
				37.00
6382	Tobacco Manure, Wrapper Brand.	Mapes' F. & P. G. Co., N. Y. City.	Hartford Branch, Hartford.	46.00
6163	Tobacco Fertilizer.	Rogers Mfg. Co., Rockfall.	Manufacturer.	45.00
6233	Stockbridge Top-Dressing.	Bowker Fertilizer Co., Boston, Mass.	W. O. Goodsell, Bristol.	38.00
			Balch & Platt, Norfolk.	40.00
6258	High Grade Tobacco Manure.	Bradley Fertilizer Co., Boston, Mass.	Loomis Bros., Granby.	46.00
			C. F. Tallard & Son, Broad Brook.	46.00
6250	Grass and Grain Spring Top-Dressing.	Mapes' F. & P. G. Co., N. Y. City.	Mapes' Branch, Hartford.	38.00
			Edward L. Strong, Colchester.	39.00
6206	Special Potato Manure.	Crocker Fertilizer & Chemical Co., Buffalo., N. Y.	H. C. Aborn & Son, Ellington.	36.00
			Orlando Jones, Highwood.	40.00
			F. B. Newton, Plainville.	42.00
6348	Potato Manure.	C. D. Parks, Danbury.	Manufacturer.	35.00
6210	Complete Potato Manure.	H. J. Baker & Bro., N. Y. City.	C. O. Jelliff & Co., Southport.	38.00
			H. T. Miner, Vernon.	40.00
			Saxton & Strong, Bristol.	41.00
			Webster & Atwater, New Britain.	42.50

ANALYSES.—*Continued.*

Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
					Total Nitrogen.					Total.		Available.		Found.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	As Muriate	Total.	Guaranteed.
$35.29	27.5	....	3.10	3.07	6.17	*5.7*	3.97	2.21	.84	7.02	*6.0*	6.18	*5.0*	.92	10 56	*10.0*
29.59	28.4	.43	2.20	2.42	5.05	*4.9*	4.02	1.36	.42	5.80	*5.5*	5.38	*4.5*	7:25	9.82	*9.0*
23.86	29.9	....	....	3.38	3.38	*3.3*	5.22	1.53	2.90	9.65	....	6.75	*6.0*	.81	6.05	*5.4*
36.58	31.2	2.90	....	2.91	5.81	*5.8*	1.09	5.74	4.50	11.33	....	6.83	*4.0*	.56	10.12	*10.0*
24.37	31.3	.11	....	2.82	2.93	*2.5*	1.92	8.09	.63	10.64	*9.0*	10.01	....	6.35	6.35	*5.0*
30.12	32.8	....	2.64	1.76	4.40	*4.5*	4.27	.99	.37	5.63	....	5.26	*4.0*	.85	11.51	*10.0*
28.58	32.9	.69	....	3.26	3.95	*3.5*	2.19	6.27	1.44	9.90	*9.0*	8.46	....	.73	8.40	*8.8*
26.10	34.1	.42	....	2.02	2.44	*2.5*	10.12	4.49	.31	14.92	*8.0*	14.61	*7.0*	3.97	3.97	*4.0*
35.56	34.9	....	2.80	3.15	5.95	*5.8*	2.00	4.83	.95	7.78	*6.0*	6.83	*5.0*	.48	10.98	*10.0*
27.22	35.9	1.21	.25	2.28	3.74	*3.7*	5.26	4.39	1.10	10.75	*8.0*	9.65	*7.0*	6.89	6.89	*7.0*
33.80	36.0	1.78	2.28	2.14	6.20	*6.2*	.35	4.40	.69	5.44	*4.5*	4.75	....	.77	11.17	*10.5*
*33.04	36.2	1.25	....	3.41	4.66	*4.9*	1.30	4.93	.70	6.93	*8.0*	6.23	....	....	13.47	*11.0*
29.07	37.6	2.91	....	2.19	5.10	*4.9*	4.54	3.00	2.39	9.93	*6.0*	7.54	....	6.81	6.81	*6.0*
33.40	37.7	....	3.12	2.65	5.77	*5.8*	1.76	3.70	1.32	6.78	*4.0*	5.46	*7.0*	.76	10.53	*10.8*
27.42	38.6	1.04	.75	2.86	4.65	*4.1*	3.15	4.17	.60	7.92	*7.0*	7.32	*5.0*	7.19	7.19	*5.0*
25.93	38.8	....	....	4.12	4.12	*3.7*	5·87	2.36	.98	9.21	....	8.23	*8.0*	5.75	5.75	*5 5*
24.92	40.4	.12	....	2.88	3.00	*2.9*	.59	8.10	1.98	10.67	*8.0*	8.69	....	6.90	6.90	*7.0*
28.49	40.4	.47	1.30	2.09	3.86	*3.3*	5.42	1.52	.57	7.51	*6.5*	6.94	*5.0*	5.33	10.29	*10.0*

* See page 142.

SPECIAL MANURES, SAMPLED BY THE STATION.—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.
6232	Corn Manure.	Mapes' F. & P. G. Co., New York City.	Mapes' Branch, Hartford.	$35.00
			Willoughby Bros., Tariffville.	37.00
6259	Complete Manure for Corn and Grain.	Bradley Fertilizer Co., Boston, Mass.	Strong & Tanner, Winsted.	38.00
			M. Beach & Son, New Milford.	40.00
6225	Potato Manure.	Mapes' F. & P. G. Co., New York City.	Mapes Branch, Hartford.	40.00
			A. Martin, Lakeville.	42.00
6173	High Grade Potato Manure.	Packers' Union Fertilizer Co., New York City.	Nathan S. Bushnell, Taftville.	32.00
			W. H. Terry, Willimantic.	32.00
			Thomas McClimon, Greenville.	33.00
6335	High Grade Soluble Tobacco Manure.	Rogers Manufacturing Co., Rockfall.	Manufacturer.	45.00
6181	High Grade Potato Fertilizer.	E. Frank Coe Co., New York City.	I. W. Dennison & Co., Mystic.	33.00
			J. A. Isham, Columbia.	33.00
			Walkley & Damery, Wethersfield.	37.00
6315	Tobacco Starter.	Mapes' F. & P. G. Co., New York City.	F. S. Bidwell, Windsor Locks.	36.00
6411	Tobacco Grower.	Bowker Fertilizer Co., Boston, Mass.	E. F. Miller, Ellington.	34.00
6286	Corn Fertilizer.	M. E. Wheeler & Co., Rutland, Vt.	John Bransfield, Portland.	30.00
			Dwight Gallup, Old Mystic.	30.00
			D. P. Bullis, Wallingford.	30.00
			N. E. Lord, Hebron.	......
			E. K. Chamberlain, East Woodstock.	32.00
6313	Fruit and Vine Manure.	Mapes' F. & P. G. Co., New York City.	Mapes' Branch, Hartford, Ct.	38.00
6372	Potato Phosphate.	Cleveland Dryer Co., Boston, Mass.	D. F. Southwick, Putnam.	30.00
6209	Complete Manure for Potatoes and Vegetables.	Bradley Fertilizer Co., Boston, Mass.	J. B. Alexander, New Britain.	39.00
			E. N. Pierce & Co., Plainville.	42.00
6364	Quinnipiac Corn Manure.	Quinnipiac Co., Boston, Mass.	W. L. L. Spencer, Lebanon.	28.00
			C. R. Hall, Coventry.	32.00
6370	Potato Manure.	Bowker Fertilizer Co., Boston, Mass.	Balsh & Platt, Norfolk.	33.00
			S. T. Welden, Simsbury.	33.00
6179	Stockbridge Corn and Grain Manure.	Bowker Fertilizer Co., Boston, Mass.	City Coal and Wood Co., New Britain.	38.00
			J. A. Lewis, Willimantic.	40.00
			C. T. Leonard, Norwalk.	40.00
6254	Complete Corn Manure.	H. J. Baker & Bro., New York City.	H. T. Miner, Vernon.	40.00
6204	Animal Corn Fertilizer.	Packers' Union Fertilizer Co., New York City.	B. E. Eddy, E. Woodstock.	30.00
			Thomas McClimon, Greenville.	30.00
6401	Complete Manure for Top Dressing Grass and Grain.	Bradley Fertilizer Co., Boston, Mass.	Billings & Hallock, Meriden.	35.00

ANALYSES.—*Continued.*

Valuation per Ton.	Percentage Diff between Cost and Valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen.		Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.		Guaranteed.
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	
$24.88	40.7	.58	.28	1.76	2.62	*2.5*	6.97	3.62	.39	10.98	*10.0*	10.59	*8.0*	6.77	6.77	*6.0*
26.85	41.5	1.16	....	2.09	3.25	*3.3*	5.04	7.21	1.66	13.91	*13.0*	12.25	*12.0*	4.96	4.96	*3.0*
28.24	41.6	1.96	.45	1.26	3.67	*3.7*	5.26	4.86	.52	10.64	*8.0*	10.12	....	.67	7.28	*6.0*
22.50	42.2	....	....	2.30	2.30	*2.1*	7.07	2.14	.82	10.03	*9.0*	9.21	*8.0*	6.46	6.46	*6.0*
*31.48	42.9	1.54	.15	2.57	4.26	*5.0*	3.41	5.50	.45	9.36	*8.0*	8.91	....	.69	10.31	*10.0*
23.12	42.7	....	.48	1.95	2.43	*2.5*	7.04	2.21	1.91	11.16	*9.0*	9.25	*9.0*	.33	5.54	*6.0*
25.17	43.0	1.40	.45	1.15	3.00	*2.5*	6.42	6.08	.86	13.36	*12.0*	12.50	*8.0*	.54	3.39	*2.5*
23.74	43.3	.75	....	1.91	2.66	*2.5*	8.22	2.65	.96	11.83	*9.0*	10.87	*7.0*	.36	4.33	*4.0*
20.85	43.9	.06	....	2.92	2.98	*1.7*	7.01	2.38	.77	10.16	*9.0*	9.39	*8.0*	2.34	2.34	*2.0*
26.32	44.4	.38	.18	1.49	2.05	*1.7*	4.58	2.82	.53	7.93	*7.0*	7.40	*5.0*	.91	12.60	*10.0*
20.73	44.8	.35	....	2.22	2.57	*2.1*	4.64	5.32	1.21	11.17	*10.0*	9.96	*8.0*	2.94	2.94	*3.0*
26.80	45.5	1.52		2.38	3.90	*3.7*	5.01	4.41	1.21	10.63	*9.0*	9.42	*8.0*	6.27	6.27	*6.0*
19.05	46.9	.32	....	1.82	2.14	*2.1*	4.49	5.87	2.10	12.46	*10.0*	10.36	*9.0*	1.60	1.60	*1.5*
22.42	47.2	.59	....	2.00	2.59	*2.5*	6.78	3.31	1.19	11.28	*10.0*	10.09	*8.0*	4.42	4.42	*4.0*
27.08	47.7	1.78	....	1.88	3.66	*3.3*	8.27	2.88	1.21	12.36	*10.0*	11.15	*8.0*	5.05	5.05	*4.0*
26.64	50.2	.17	2.41	1.55	4.13	*4.9*	6.05	1.51	.36	7.92	....	7.56	*6.2*	7.00	7.00	*7.0*
19.95	50.4	trace	....	2.74	2.74	*2.5*	7.01	2.13	1.00	10.14	*9.0*	9.14	*8.0*	2.27	2.27	*2.0*
22.72	54.0	5.00	....	....	5.00	*4.9*	1.95	3.43	1.22	6.60	*6.0*	5.38	*5.0*	.98	2.75	*2.5*

* See page 143.

Special Manures, Sampled by the Station.—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.
6283	Potato Manure.	M. E. Wheeler & Co., Rutland, Vt.	N. E. Lord, Hebron.	------
			E. K. Chamberlain, East Woodstock.	$34.00
			John Bransfield, Portland.	**35.00**
			E. Murray, Newtown.	36.00
6278	Vegetable, Vine and Tobacco.	Great Eastern Fertilizer Co., Rutland, Vt.	R. D. Wilson, Winsted.	33.00
			F. V. Cantrell, Darien.	36.00
			W. L. Baxter, New Canaan.	36.00
				35.00
6176	Stockbridge Special for Potatoes and Vegetables.	Bowker Fertilizer Co., Boston, Mass.	E. B. Clark & Sons, Milford.	36,00
			J. A. Lewis, Willimantic.	38.00
			P. L. Lathrop, Coventry.	**40.00**
			Browning & Gallup, New London.	40.00
6413	Fruit Fertilizer.	M. E. Wheeler & Co., Rutland, Vt.	Dwight & Gallup, Old Mystic.	**29.00**
6397	Americus Potato and Tobacco Fertilizer.	Williams & Clark Fertilizer Co., N. Y. City.	W. B. Martin, Rockville.	**34.00**
6231	Potato Manure.	Quinnipiac Co., Boston, Mass.	C. H. Banks, Greenfield Hill.	32.00
			F. S Bidwell, Windsor Locks	33.00
			L. A. Grannis, Fair Haven.	**34.00**
			A. J. Martin, Wallingford.	35.00
			Olds & Whipple, Hartford.	35.00
6083	Potato Special Fertilizer.	Milsom Rendering and Fertilizer Co., Buffalo, N. Y.	W. K. Ackley, East Hartford	**39.00**
6288	Special Potato Manure.	Pacific Guano Co., Boston, Mass.	Carlos Bradley, Ellington.	31.00
			S. A. Burnham, Andover.	34.00
			Geo. Webster, Rockville.	35.00
				33.00
6284	Americus Potato Phosphate.	Williams & Clark Fertilizer Co., N. Y. City.	S. A. Flight, New Haven.	32.00
			F. B. Austin, Silver Mine.	33.00
			John H. Avery, Lebanon.	**34.00**
			Edward L. Strong, Colchester.	34.00
			G. H. Clark, Granby.	35.00
			S. E. Brown, Collinsville.	35.00
			A. B. Garfield, East Canaan.	36.00
	Grain and Grass Fertilizer.	Great Eastern Fertilizer Co., Rutland, Vt.	W. L. Baxter, New Canaan.	**36.00**
			F. V. Cantrell, Darien.	36.00
6208	Potato, Hop and Tobacco Phosphate.	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	H. C. Aborn & Son, Ellington	34.00
			Orlando Jones, Highwood	**35.00**
			E. A. Davis & Son, Danielson	36.00
			F. B. Newton, Plainville.	38.00

ANALYSES—*Continued.*

Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen.		Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.		Guaranteed.
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	
$22.70	54.2	----	----	2.42	2.42	*2.1*	7.04	2.26	.84	10.14	*9.0*	9.30	*8.0*	6.20	6.20	*3.2*
22.61	54.8	----	----	2.28	2.28	*2.1*	7.09	2.27	.82	10.18	*9.0*	9.36	*8.0*	6.47	6.47	*6.0*
25.76	55.3	1.49	----	1.93	3.42	*3.3*	3.38	3.23	2.42	9.03	*8.0*	6.61	*5.0*	9.36	9.36	*10.0*
18.50	56.8	----	----	----	----	----	5.87	4.47	1.02	11.36	*12.0*	10.34	*10.0*	7.95	7.95	*8.0*
21.63	57.2	.35	----	2.17	2.52	*2.1*	4.69	6.00	1.51	12.20	*9.0*	10.69	*8.0*	3.15	3.15	*3.0*
21.21	60.3	.23	----	2.51	2.74	*2.5*	3.84	3.35	1.78	8.97	*7.0*	7.19	*6.0*	5.87	5.87	*5.0*
24.15	61.5	----	----	1.97	1.97	*1.7*	7.73	2.13	.78	10.64	*10.0*	9.86	*8.0*	.59	7.75	*8.0*
20.36	62.0	.63	.20	1.91	2.74	*2.5*	3.07	4.02	1.66	8.75	*7.0*	7.09	*5.0*	5.17	5.17	*5 0*
20.70	64.3	.38	.12	2.12	2.62	*2.5*	4.00	3.70	1.59	9.29	*7.0*	7.70	*6.0*	5.14	5.14	*5.0*
21.90	64.4	----	----	3.20	3.20	*2.9*	7.14	2.52	1.12	10.78	*9.0*	9.66	*8.0*	2.35	2.35	*2.0*
21.06	66.2	----	----	2.17	2.17	*2.1*	7.57	3.20	1.04	11.81	*10.0*	10.77	*10.0*	3.37	3.37	*3.2*

SPECIAL MANURES, SAMPLED BY THE STATION.—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.
6182	Vegetable and Vine Fertilizer.	Read Fertilizer Co., N. Y. City.	L. D. Post, Andover.	$34.00
			J. A. Silliman, New Canaan.	35.00
6312	Cumberland Potato Fertilizer.	Cumberland Bone Phosphate Co., Boston, Mass.	Wm. Bartell, Ore Hill.	34.00
6227	Ammoniated Wheat and Corn Phosphate.	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	H. C. Aborn & Son, Ellington.	33.00
			C. H. Wheeler, East Canaan.	35.00
6310	Potato, Tobacco and Hop Fertilizer.	Niagara Fertilizer Works, Buffalo, N. Y.	Wm. Higgins, New London.	32.00
6399	Americus Corn Phosphate.	Williams & Clark Fertilizer Co., N. Y. City.	G. H. Clark, Granby.	35.00
6401	Potato Special.	Walker, Stratman & Co., Pittsburgh, Pa.	White & Juno, Rockville.	38.00
6177	Potato Manure.	Bradley Fertilizer Co., Boston, Mass.	Raymond Bros., South Norwalk.	34.00
			D. L. Clark, Milford.	35.00
			J. B. Alexander, New Britain.	36.00
6202	Oats and Clover Fertilizer.	Packers' Union Fertilizer Co., N. Y. City.	B. E. Eddy, East Woodstock.	25.00
6358	Standard Potato and Tobacco Fertilizer.	Standard Fertilizer Co., Boston, Mass.	Nathan S. Bushnell, Taftville.	33.00
			A. L. Kuren, Tolland.	35.00
6085	Potato, Hop and Tobacco Phosphate.	Milsom Rendering & Fertilizer Co., Buffalo, N. Y.	W. K. Ackley, East Hartford.	39.00
6178	Practical Potato Special.	Read Fertilizer Co., N. Y. City.	John R. Babcock, Mystic.	30.00
			Nathan S. Bushnell, Taftville.	30.00
6390	Grass Fertilizer.	Quinnipiac Co., Boston, Mass.	O. S. Olmstead, Melrose.	31.00
6084	Wheat, Oats and Barley Phosphate.	Milsom Rendering & Fertilizer Co., Buffalo, N. Y.	W. K. Ackley, East Hartford.	33.00
6317	Universal Grain Grower.	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	C. H. Wheeler, East Canaan.	30.00
6412	Grass and Oats.	M. E. Wheeler & Co., Rutland, Vermont.	C. K. Chamberlain, East Woodstock.	28.00
			E. E. Pitney, Ellington.	....
6309	Niagara Grain and Grass Grower.	Niagara Fertilizer Works, Buffalo, N. Y.	Wm. Higgins, New London.	26.50

Analyses.— *Continued.*

Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen. Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen. Found.	Total Nitrogen. Guaranteed.	Phosphoric Acid. Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Potash. Found. As Muriate.	Found. Total.	Guaranteed.
$20.40	66.7	trace	----	1.81	1.81	*1.7*	5.61	1.44	.63	7.68	*7.0*	7.05	*6.0*	8.30	8.30	*8.0*
*20.35	67.1	.47	----	1.85	2.32	*2.1*	5.36	4.71	1.65	11.72	*11.0*	10.07	*9.0*	2.92	2.92	*3.0*
19.64	68.0	----	----	2.26	2.26	*2.1*	7.89	2.45	1.42	11.76	*10.0*	10.34	*10.0*	1.80	1.80	*1.6*
18.71	71.0	----	----	2.18	2.18	*1.7*	5.68	1.78	3.73	11.19	*9.0*	7.46	*8.0*	3.43	3.43	*2.7*
20.35	72.0	.35	----	2.07	2.42	*2.1*	5.55	5.54	1.23	12.32	*10.0*	11.09	*9.0*	1.62	1.62	*1.5*
22.01	72.6	----	----	1.74	1.74	*1.7*	8.27	3.18	.91	12.36	----	11.45	*9.0*	----	4.50	*5.0*
20.04	74.6	.69	----	2.03	2.72	*2.5*	3.12	3.81	1.41	8.34	*8.0*	6.93	*6.0*	5.22	5.22	*5.0*
14.21	75.9	----	----	----	----	----	6.32	4.87	1.54	12.73	----	11.19	*11.0*	1.97	1.97	*2.0*
†19.82	76.6	.46	----	1.88	2.34	*2.1*	4.43	5.40	1.76	11.59	*9.0*	9.83	*8.0*	2.61	2.61	*3.0*
22.03	77.0	----	----	2.58	2.58	*2.5*	7.11	1.47	.55	9.13	*9.0*	8.58	----	5.79	5.88	*6.0*
16.62	80.5	trace	----	1.05	1.05	*.8*	3.44	2.62	.48	5.54	*5.0*	6.06	*4.0*	7.88	7.88	*8.0*
18.61	82.7	3.64	----	----	3.64	*3.9*	2.21	3.43	1.18	6.82	*6.0*	5.64	*5.0*	.83	2.53	*2.0*
17.75	85.9	----	----	1.59	1.59	*1.2*	8.75	1.57	.59	10.91	*9.0*	10.32	*8.0*	.37	1.90	*2.0*
15.41	94.7	----	----	1.15	1.15	*.8*	5.41	1.58	3.32	10.31	----	6.99	*7.0*	3.70	3.70	*2.7*
14.32	95.5	----	----	----	----	----	5.95	5.46	.92	12.33	----	11.41	*11.0*	2.16	2.16	*2.0*
12.87	105.9	----	----	1.00	1.00	*.8*	5.12	1.97	3.78	10.87	*8.0*	7.09	*7.0*	1.07	1.07	*1.1*

* See page 142. † See page 143.

Home Mixtures.

Many farmers buy fertilizer chemicals and make their own mixtures on the farm instead of buying ready-mixed goods.

In some cases before payment is made, the chemicals themselves are sent to the Station for analysis to learn whether they fully meet the seller's guarantee.

The mixtures themselves are also sometimes sent for analysis.

Eleven analyses of these home mixtures are given in the table on page 155, together with the formulas used.

In most cases the analysis of the mixture agrees well with its "calculated composition," which is reckoned from the weights and the average composition of the fertilizer chemicals used.

The schedule of trade values by which the valuations are calculated is the same as is used for factory-mixed goods, stated on page 98. The cost per ton, given in the table, does not in any case include cost of mixing, which may amount to one or two dollars per ton, but it covers the regular cash ton prices of the chemicals, excluding car-lot quotations or special discounts.

The average cost of eight samples of home mixtures is $27.66, or adding two dollars per ton for mixing, $29.66. The average valuation of the same is $26.05 and the percentage difference between cost and valuation is 13.9.

MISCELLANEOUS FERTILIZERS AND MANURES.

Cotton Hull Ashes.

In the table on page 157 are tabulated thirty-one analyses of this material, most of them from stock bought for fertilizing tobacco lands.

These analyses show the usual wide range of composition. Thus, the potash, *soluble in water*, which is the ingredient for which the ashes are specially bought, ranges from 15.40 (excluding No. **6169**) to 30.64 per cent., and the phosphoric acid from 5.96 to 11.68 per cent.

The *averages* of these two ingredients have been, respectively, 23.1 and 9.7 per cent.

Allowing 5½, 5 and 2 cents per pound, for the water-soluble, citrate-soluble and insoluble phosphoric acid, respectively, potash soluble in water has cost from 3.8 cents to 10.9 cents per pound and on the average 6.6 cents.

HOME-MIXTURES, ANALYSES AND VALUATIONS.

Station No.	Made by.	Formula, Pounds per ton of Mixture. Nitrate of Soda.	Cotton Seed Meal.	Castor Pomace.	Blood, Bone and Meat.	Tankage.	Acid Phosphate.	Dissolved Bone Black.	Ground Bone.	Muriate of Potash.	Analyses. Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen.	Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Total Phosphoric Acid.	Potash.	Cost (Unmixed) and Valuation. Cost per Ton.	Valuation per Ton.
5891	S. D. Woodruff & Sons, Orange	150	900	----	----	----	700	----	----	250	.72	----	2.37	3.09	4.42	1.84	.48	6.74	6.61	$ 26.00	21.42
6118	S. D. Woodruff & Sons, Orange										.21	2.18	2.49	4.88	5.38	3.64	1.38	10.40	3.41	------	27.38
6119	S. D. Woodruff & Sons, Orange										1.19	----	3.02	4.21	3.89	4.38	1.77	10.04	9.55	------	29.64
6190	A. C. Lake, Bethlehem	125	500	----	----	500	600	----	----	275	.89	----	3.31	4.20	3.66	4.29	1.12	9.07	7.12	24.25	26.85
6200	F. S. Hopson, Stratford	125	----	----	800	----	----	800	----	275	1.22	----	2.71	3.93	5.29	4.81	1.36	11.46	7.73	28.99	29.01
6201	Andrew Ure, New Haven	100	----	800	----	----	800	----	----	300	.95	----	2.05	3.00	4.61	2.20	.33	7.14	6.79	20.00	21.82
6306	C. E. Scranton, Madison	100	----	800	----	----	800	----	----	300	.67	----	1.71	2.38	4.24	2.24	.44	6.92	8.15	26.37	21.02
6307	D. Fenn, Milford	210	----	----	----	790	----	630	160	210	1.46	----	2.34	3.80	5.28	6.07	1.83	13.18	6.58	29.59	29.02
6353	G. F. Platt & Son, Milford	200	----	----	700	----	----	700	300	100	1.60	----	2.94	4.54	7.97	3.48	1.82	13.27	2.97	31.88	28.20
6356	N. D. Platt, Milford	100	----	----	666	----	----	666	166	166*	.99	.50	2.85	4.34	3.74	2.58	.81	7.13	12.91	34.19	31.06
6496	J. J. Wilcox, Meriden	100	----	----	----	750	----	750	----	400	.68	----	2.36	3.04	6.48	4.10	1.08	11.66	8.79	------	28.02

* Also 168 pounds of sulphate of potash and 68 pounds sulphate of ammonia.

This potash is in the form of carbonates and phosphates and is particularly prized for tobacco, though it is well suited for other crops.

The analyses which follow were made on samples of cotton hull ashes offered, but not yet sold, into this State.

5615. Offered to Edward Austin, of Suffield, by southern mills as cotton hull ashes. On receipt of the analysis he naturally declined to handle them.

6330. Offered to L. H. Brewer, Hockanum, by F. W. Brode & Co.

ANALYSES.

	5615	6330
Soluble Phosphoric Acid	----	.80
Reverted " "	----	4.00
Insoluble " "	----	1.19
Potash Soluble in Water	3.02	10.17
Valuation per ton	----	$15.53

WOOD ASHES.*

These are usually regarded as a potash-fertilizer, but are also and sometimes chiefly valuable as a source of lime, in the form of carbonate.

The twenty-two samples received this season have contained from 3 to 6.7 per cent. of potash soluble in water, and from 1 to 2.6 per cent. of phosphoric acid. In twenty-one samples lime has ranged from 24.5 to 40.8 per cent., carbonic acid from 16 to 28 per cent., sand or other insoluble mineral matters from 3 to 18 per cent. and charcoal from 1 to 7 per cent. The cost has varied from $6.69 to $14.00.

The averages are as follows: For comparison, the averages of 16 samples examined last year are also given (Station Report for 1895, p. 62).

AVERAGE COMPOSITION AND COST OF WOOD ASHES.

	1896	1895
Potash, soluble in water	5½ per cent.	4½ per cent.
Phosphoric acid	1½ "	1½ "
Lime	32½ "	34 "
Sand and soil	11 "	12½ "
Charcoal	2½ "	2 "
Cost	$10.36	$10.75

* By S. W. Johnson. The analyses are on page 159.

Analyses of Cotton Hull Ashes.

Station No.	Dealer or Purchaser.	Sampled by.	Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Potash Soluble in Water.	Cost per Ton.	Valuation per ton.	Potash Costs per Pound in Cents.
6298	John Willoughby, Tariffville	Alfred H. Griffin, Granby	3.71	7.70	.27	30.64	$35.00	$42.53	3.8
6180	Olds & Whipple, Hartford	E. P. Brewer, Silver Lane	2.83	9.72	.28	28.30	40.00	41 24	4.7
6139	C. N. Dexter & Son, Windsor Locks	John P. Griswold, Poquonock	2.72	7.38	.48	28.78	40.00	39.34	5.1
6149	F. S. Bidwell, Windsor Locks	Dan. O. King, Windsor Locks	3.10	7.68	.63	27.12	40.00	38.47	5.3
5444	R. A. Parker, Warehouse Point	Station Agent	1.60	8.64	.25	27.57	40.00	38.07	5.4
6153	I. L. Spencer, Suffield	Luke F. Woodworth, Thompsonville	2.61	7.43	.50	26.38	40.00	36.88	5.6
6044	I. L. Spencer, Suffield	E S. Seymour, Windsor Locks	2.24	8.25	.60	26.04	40.00	36.99	5.6
5885	Olds & Whipple, Hartford	Olin Wheeler, Buckland	2.39	8.10	.27	30.01	45.00	40.85	5.7
5628	Olds & Whipple, Hartford	Ernest J. Brewer, Silver Lane	.77	8.69	.33	26.50	40.00	36.17	5.7
6130	I. L. Spencer, Suffield	Willard C Sikes, Thompsonville	2.99	8.19	.50	24.72	40.00	36.40	5.7
6043	I. L. Spencer, Suffield	F. B. Hathaway, Windsor Locks	1.17	6.45	.23	27.92	40.00	35.75	5.8
6299	I. L. Spencer, Suffield	G. A. Harmon, Suffield	2.14	8.62	.55	23.44	40.00	34.63	6.1
6170	American Cotton Oil Co.	R. W. Cowles, Tariffville	.96	7.79	.51	19.26	32.00	28.31	6.2
5887	R. A. Parker, Warehouse Point	E. F. Thompson, Warehouse Point	1.07	8.67	.29	23.72	40.00	33.69	6.3
6116	I. L. Spencer, Suffield	C. J. Sheldon, W. Suffield	1.90	7.48	.69	23.78	40.00	33.63	6.4
5771	I. L. Spencer, Suffield	Chas. M. Owen, Suffield	trace	7.19	.36	25.04	40.00	32.37	6.5
6189	H. S. Chapman, New York City	H. S. Chapman & Co., Thompsonville	.72	9.12	.55	19.98	36.00	30.11	6.5
6079	Geo. Douglass, Thompsonville	A. C. Russell, Suffield	.91	9.20	.32	19.34	36.00	29.67	6.6
6188	H. S. Chapman, 271 Broadway, N. Y.	Arthur Sikes, Suffield	.81	6.68	.62	21.30	36.00	29.12	6.6
6012	I. L. Spencer, Suffield	F. B. Hathaway, Windsor Locks	1.18	7.01	.48	23.50	40.00	32.00	6.7
6450	I. L. Spencer, Suffield	I. O. Van Gelder, W. Suffield	1.06	7.59	.68	22.06	40.00	31.09	7.0
6038	W. W. Cooper, Suffield	Chas. H. Wells, Suffield	.54	7.81	.41	20.24	38.00	28.80	7.2
6039	Charles L. Spencer	Byron Loomis, Suffield	1.10	8.76	.30	19.98	40.00	30.07	7.4
5618	W. W. Cooper, Suffield	Oliver C. Rose, West Suffield	.51	6.61	.77	20.30	38.00	27.78	7.5
5886	G. A. Douglass, Thompsonville	C. D. Woodworth, Thompsonville	.79	8.40	.47	17.64	36.00	27.10	7.5
6111	I. Luther Spencer, Suffield	Henry M. Rose, West Suffield	1.28	7.76	.61	20.40	40.00	29.81	7.5
5707	W. W. Cooper, Suffield	Oliver C. Rose, W. Suffield	none	7.13	.55	18.52	38.00	25.87	8.3
6107	I. L. Spencer, Suffield	Chas. D. Cannon, Windsor Locks	1.01	9.11	.49	15.40	40.00	25.82	9.6
6168	I. L. Spencer, Suffield	Oliver C. Rose, W. Suffield	....	4.74	1.22	16.02	40.00	21.25	10.9
6169	American Cotton Oil Co.	R. W. Cowles, Tariffville	.80	2.75	1.35	4.82	32.00	8.99	29.0
5809	J. C. Eddy, agent for G. H. & J. H. Hale	D. L. Brockett, Suffield	....	6.84	.49	19.90	....	26.94	....

The variations in the composition and quality of these ashes are very considerable. Of the samples analyzed this year, ten contain less than 5 per cent. of water-soluble potash and nine less than 30 per cent. of lime. Of the latter, it is but just to state, that all except two contain over 28 per cent. of lime. The average composition has been nearly alike in the two years.

In collecting wood ashes from log-heaps on new-cleared land it is difficult to avoid taking up with them some of the underlying earth. It is very easy also to adulterate them purposely with leached wood ashes, coal ashes or soil. But when "sand and soil" amount to 20 per cent. or more, as was the case in three of last year's samples, it is a question whether the "goods" should not be sold by the acre instead of the bushel or ton.

On the other hand, unadulterated wood ashes may unavoidably include considerable proportions of sand and soil. In our Annual Report for 1879, p. 45, are given three analyses of ashes made in a house stove at Branford that contained, respectively, 18, 22 and 27 per cent. of sand, etc. In ashes carefully prepared at this Station from a weighed quantity of chestnut body wood, cut and seasoned on the premises and burned on a clean brick hearth, were found 15.8 per cent. of "sand and silica." See Annual Report for 1883, p. 69.

In the latter case about 1½ ounces of sand and soil adhered to the rough surfaces of 100 pounds of wood and bark. When this wood was burned there remained, all told, one-half of one per cent. or 8 ounces of ashes, from which the sand, etc., was separated and weighed in the process of analysis.

The low content of water-soluble potash, viz. 3.01 and 2.98 per cent. in **5612** and **5810**, respectively, which is but one-half that found in five other of these samples, does not necessarily indicate adulteration or partial leaching out of soluble matters by exposure to rain. The ashes of chestnut body wood, prepared at this Station as already mentioned, contained but 3 per cent. of water-soluble potash. In the ashes of pine wood less than 2 per cent. of water-soluble potash is sometimes present. Ashes from large or old trees grown on very poor land may contain much less potash, per cent., than exists in ashes of young wood produced on good soil. Ashes from new twigs yield the largest proportion of potash up to 20, 30 or more per cent., and the per cent. of potash in them is usually much greater in early spring than in the following autumn, as during the summer's growth

Sources, Analyses and Cost of Wood Ashes.

Station No.	Dealer.	Sampled or Sent by.	Potash Soluble in Water.	Potash Soluble Only in Acids.	Phosphoric Acid.	Lime, Calcium Oxide.	Carbonic Acid.	Sand and Soil.	Charcoal.	Cost per Ton.
5612*	A. Hartness, Detroit, Mich.	J. N. Barnes, Yalesville	3.09	0.80	1.41	29.07	18.84	12.34	2.35	$ 9.50
5613*	" " "	L. B. Yale, Meriden	6.10	0.77	1.71	29.37	17.59	16.95	2.20	9.50
5636*	" " "	A. E. Plant, Branford	6.66		1.47	29.15	16.66	13.86	1.71	9.50
5637*	" " " 2d car	" " "	6.55		1.65	28.60	16.09	14.17	1.81	9.50
5776	" " "	G. E. Pierce, Roxbury	4.98		1.30	....	....	....	...	11.00
6448	" " "	H. C. C. Miles, Milford	6.19		1.56	32.42	16.89	12.23	3.27	14.00
5810	" " "	John Ives, Meriden	2.98		1.39	36.69	23.69	16.29	3.31	6.69
6498	" " "	J. H. Webb, New Haven	4.75		1.24	28.80	17.55	11.72	1.44	9.25
6499*	" " "	J. Norris Barnes, Yalesville	4.81		1.39	24.46	16.27	16.90	2.30	10.00
6500*	" " "	" " "	3.79		1.14	28.49	18.06	10.17	1.37	10.00
6502	" " "	Geo. E. Pierce, Roxbury	5.70		1.71	40.76	28.14	7.35	0.99	11.50
5022†	Munroe, Lalor & Co., Oswego, N. Y.	" " "	4.25		1.32	36.00	22.16	11.28	1.50	11.00
6246*	" " " "	W. F. Whitney, Yalesville	3.90		1.05	32.37	18.46	11.14	3.69	10.00
6272	" " " "	J. H. Burton, New Haven	4.64		1.45	31.95	20.33	14.66	4.20	11.00
6488*	" " " "	A. N. Clark. Milford	3.44	1.05	2.65	29.43	19.37	6.96	1.62	10.50
6093*	" " " "	W. G. & F. Comstock, E. Hartford	5.97		1.51	37.16	21.94	5.12	2.09	12.00
6341	" " " "	T. D. Barclay, Kent	5.40		1.23	40.42	21.38	2.99	1.06	11.00
6273	" " " "	Atwater Brothers, New Haven	5.41		1.59	34.29	23.69	11.39	2.97	11.00
6274*	Allison, Stroup & Frost, New York City	W. H. H. Miller, Glastonbury	4.10		1.39	25.66	15.21	18.05	7.17	9.50
6148	James Perkins, Suffield	C. A. Birge, Suffield	4.09		2.10	37.82	24.32	7.47	4.49	11.00
6247	Schwartz Bros., Rockville	Talcott Bros., Talcottville	5.64		1.57	34.49	20.48	6.73	1.75	10.60
6505*		Dwight N. Clark. Woodbridge	5.16		1.49	38.44	22.10	4.28	...	10.00
		Highest per cent. or cost	6.66		2.65	40.76	28.14	18.05	7.17	14.00
		Lowest " "	2.98		1.05	24.46	16.09	2.99	0.99	6.69
		Average " "	5.53		1.51	32.65	19.96	11.05	2.56	$10.36

* Carloads.

† Contained 7.64 per cent. of moisture.

lime and magnesia accumulate in the wood and bark, while potash is largely transferred to the new-formed buds.

When ashes containing fine sand (quartz or silica), are intensely heated, some of the potash and silica may melt together, forming a slag or cinder, which does not yield its alkali to water and requires strong acids to dissolve out the potash. In samples **5612, 5613** and **6488** the amounts of potash soluble only in acids were determined. These amounts, respectively, were 0.80, 0.77 and 1.61 per cent.; this potash insoluble in water can be of little or no use to the land or crops.

In respect to **5612** it must be concluded that either the car load or the sample, or both, had been half leached. This is an inevitable inference from the statement that **5613** "was the same ashes as **5612** but from another car," and from the fact that, except as regards water-soluble potash, the two samples have practically the same composition.

As respects the cost of lime in these ashes we find that, taking the average price of the ashes, viz. $10.36 a ton, and allowing 5 cents a pound each for phosphoric acid and water-soluble potash, the average cost of pure lime (calcium oxide) in the 21 samples whose lime content is stated, would be 51 cents a hundred pounds. In **6499,** at $10.00 a ton, the hundred weight of lime cost 78 cents. The lime in **6448,** for which was paid $14.00 the ton, cost 96 cents a hundred weight. But in **5810,** bought for $6.69 per ton, lime was obtained for 32 cents per hundred.

Slacked Oyster Shell Lime can now be got in New Haven, of H. A. Stevens, 39 South Front St., for 12 cents per bushel, in bulk, f.o.b. cars. The bushel is stated by Mr. Stevens to weigh about 50 lbs. The ton of Oyster Shell Lime, accordingly, costs $4.80 on cars at New Haven. If containing 65½ per cent. of pure lime (calcium oxide), as did a sample analyzed by this Station in 1892, the hundred pounds of pure lime would cost 37 cents.

Lime Kiln Ashes.*

5614. Sampled and sent by Canfield Bros., East Canaan.

6497. Bought of the Canaan Lime Co., Canaan. Sampled and sent by Lyman H. Francis, Meriden. Cost $3.75 per ton, delivered at Meriden.

* By S. W. Johnson.

ANALYSES.

	5614	6497
Potash soluble in water	1.47	1.75
Phosphoric acid	1.30	.65
Lime	38.52	36.57
Magnesia	17.32	17.45
Carbonic acid	27.58	----
Charcoal	1.14	6.59
Sand and Soil	2.01	1.89
Moisture, combined water and other matters (by difference)	27.98	35.10*
	100.00	100.00

These "Ashes" consist in large part of carbonates of lime and magnesia coming from the magnesian limestone which occurs in the Canaan region, and in smaller part of carbonates of potash and lime, of phosphoric acid, charcoal, etc., from the ashes of the fuel consumed in burning the limestone. For use as a fertilizer or amendment, applied to land, we may consider lime and magnesia as of equal value, and may class them together in comparing the value or cost of these materials with that of other sources of lime. In **6497** the cost of lime and magnesia was 51 cents per hundred pounds at Meriden.

These Lime Kiln Ashes are now put on cars at Canaan for $2.25 per ton in bulk, by the Canaan Lime Co. They weigh about 75 lbs. per bushel.

GROUND TOBACCO STEMS AND TOBACCO DUST.

6109. "Tobacco Dust," stated to be floor sweepings from a mill where tobacco stems are ground. It was packed in barrels and was "to be sold according as it analyzes." Sampled and sent by G. A. Harmon, Suffield, from stock of Wm. S. Pinney, Suffield.

5626. Ground Tobacco Stems from the Henderson Tobacco Co., Danville, Va. Sampled and sent by J. H. Hale. Cost per ton $7.50, f.o.b., Danville.

5884. Ground Tobacco Stems. Sold by Olds & Whipple Hartford. Sampled and sent by Wm. S. Pinney, Suffield.

6214. Ground Tobacco Stems. Sold by Olds & Whipple Hartford. Sampled and sent by H. S. Frye, Poquonock.

ANALYSES OF TOBACCO STEMS AND TOBACCO DUST.

	6169	5626	5884	6214
Nitrogen	1.91	1.18	2.58	3.13
Phosphoric acid	.52	.56	.70	.86
Potash	1.96	5.16	7.06	9.63
Chlorine				trace.
Cost per ton	$7.00	7.50*	20.00	20.00
Valuation per ton	$7.00	7.99	13.88	17.91

* f.o.b. Virginia (?).

For valuation, nitrogen, phosphoric acid and potash are reckoned at 12, 4½ and 5 cents per pound, respectively.

SWAMP MUCK.*

6491. A sample of swamp muck, received from E. R. Gillette, Colchester, is remarkable for containing one-third its weight of matters freely dissolved by cold water, consisting chiefly of sulphates and humates of iron, aluminum and manganese. Its composition was found as follows:

ANALYSIS OF SWAMP MUCK.

Soluble in water.	Sulphuric Acid (SO_3)	9.32	33.97
	Oxides of Iron, Aluminum and Manganese	9.80	
	Humic Acid (by difference)	14.85	
Insoluble in water.	Humus (by difference)	30.22	66.03
	Sand and Soil	35.81	
			100.00

The organic matter (humic acid and humus) contained 0.51 per cent of nitrogen.

The muck was half-dry when received. The analysis refers to the substance completely dried at 212° F.

This sample has the sourish odor that is characteristic of a mixture of vegetable matter and oil of vitriol. Its taste is acid and astringent like that of green vitriol (copperas, also known as protosulphate of iron and as ferrous sulphate), which is, in fact, its chief water-soluble ingredient.

Such muck is poisonous to vegetation. If well mixed with a quarter its weight of lime or wood ashes, the iron and aluminum sulphates will be decomposed, and after a little exposure to the air it will become harmless.

* By S. W. Johnson.

REVIEW OF THE FERTILIZER MARKET.

FOR THE YEAR ENDING NOVEMBER 1ST, 1896.

BY E. H. JENKINS.

NITROGEN.

Nitric Nitrogen.

The *wholesale* New York quotation of nitrogen in this form was 11.6 cents in November, 1895. It fell to 10.7 cents in April, and since then has risen gradually to 11.3 cents in October, 1896.

The average of the monthly quotations (given on page 168) shows that nitrate of soda has ruled lower this year than for some years previously. The figures are as follows:

Year	1896	1895	1894	1893	1892	1891	1890
Average quotation	11.1	11.4	13.0	12.7	12.1	12.9	11.5

The *retail* price of nitrogen in nitrate in this State at freight centers has been about 14.2 cents per pound.

Ammonic Nitrogen.

The *wholesale* New York quotations of nitrogen in the form of sulphate of ammonia have been very much lower than in 1894 and 1895. The monthly quotation in November, 1895, was 12.0 cents per pound. It has fallen steadily since then, being quoted in October, 1896, at 10.5 cents per pound; less than the quotation for nitrogen in nitrate of soda during the same month.

The average of the year's monthly quotations has been 11.1.

The corresponding averages for the years 1895, 1894, 1893, 1892 and 1891 were respectively, 14.3, 17.3, 15.7, 14.5 and 15.6 cents, so that sulphate of ammonia has ruled lower than for a considerable term of years.

There has been but slight demand for sulphate of ammonia in the Connecticut retail market. Nitrogen in this form has cost at retail from 15½ to 17 cents per pound.

Organic Nitrogen.

The *wholesale* New York quotations of nitrogen in the forms of red blood, black or low grade blood and concentrated tankage for each month in the year are shown in the table on page 168. Azotin has not been quoted this year.

It will be seen that nitrogen in all these forms of animal matter has been cheaper than in the years 1894 and 1895, and that both high grade and low grade blood have declined in price since January.

But these forms of organic nitrogen do not often appear in our retail market.

Low grade tankage, fish, bone, and cotton seed meal are the forms most used by those who depend on home-mixing or the use of fertilizer chemicals rather than on factory mixtures.

Phosphatic Materials.

Rough bone and ground bone were quoted at $19.50 and $22.75 per ton, wholesale, until August, when the quotations were $18.70 and $22.55, respectively. In September and October they were $16.50 and $21.75.

Rock phosphate has shown no considerable changes in quotation during the year.

Sulphuric acid quotations have remained unchanged.

Available phosphoric acid in dissolved rock phosphate has been quoted during the season at prices ranging from 2.62 to 2.73 cents per pound, *wholesale.*

Dissolved phosphate rock has during the past year figured somewhat in our retail market, and there will no doubt be a further demand for it the coming season. For analyses see pages 110 and 111.

Potash.

Muriate of Potash.

Since January, potash in this form has been quoted, *at wholesale*, at 3.60 cents per pound, the same as in 1895.

The retail price in Connecticut has ranged from 3.9 to 4.4 cents per pound.

The Double Sulphate of Potash and Magnesia.

Since April last, the *wholesale cost* of potash in this salt has been 3.94 cents, nearly four-tenths of a cent per pound less than in 1895.

At retail, in Connecticut, it has cost from 4.9 to 6.3 cents per pound.

High Grade Sulphate of Potash.

The *wholesale* New York quotation of potash in this form, which was 4.34 cents per pound in November 1895, fell in April, 1896, to 4.10 cents, and has remained at that figure ever since.

At retail, in Connecticut, potash in high grade sulphate has been sold at prices ranging from 4.9 to 6.3 cents per pound, and averaging 5.6 cents.

The review of the market quotations indicates that red and black blood, nitrate of soda and sulphate of ammonia, have fallen in price somewhat during 1896, and concentrated tankage has remained quite steady, at the same price as in 1895, till within a few months, when it has declined.

There has also been a slight decline in the quotations of potash salts.

Available phosphoric acid in dissolved rock has somewhat risen in price.

These quotations are taken from the "Oil, Paint and Drug Reporter," published in New York. The weekly quotations for each month are averaged, and this average is taken as the quotation for the month.

The following explanations will help in the examination of the market quotations, and will also show the basis on which they have been interpreted in this review:

Phosphate rock, kainit, bone, fish-scrap, tankage and some other articles are usually quoted and sold by the ton. The seller usually has an analysis of his stock, and purchasers often control this by analysis at the time of the purchase.

Sulphate of ammonia, nitrate of soda and the potash salts are quoted and sold by the pound, and generally their wholesale and retail rates do not differ very widely.

Blood, azotin and concentrated tankage are quoted at so much "per unit of ammonia." To reduce ammonia to nitrogen, multiply the per cent. of ammonia by the decimal .824 (or multiply the per cent. of ammonia by 14 and divide that product by 17). A "unit of ammonia" is one per cent., or 20 pounds per ton. To illustrate: if a lot of tankage has 7.0 per cent. of nitrogen, equivalent to 8.5 per cent. of ammonia, it is said to contain $8\frac{1}{2}$ units of ammonia, and if quoted at $2.25 per unit, a ton of it will cost $8\frac{1}{2} \times 2.25 = \$19.13$.

The term "ammonia" is *properly* used only in those cases where the nitrogen actually exists in the form of ammonia, but

it is a usage of the trade to reckon all nitrogen, in whatever form it occurs, as ammonia.

To facilitate finding the actual cost of nitrogen per pound from the cost per unit of ammonia in the market reports, the following table is given:

Ammonia at	$3.00	per unit	is equivalent to	Nitrogen at	18.2	cts. per lb.
"	2.90	"	"	"	17.6	"
"	2.80	"	"	"	17.0	"
"	2.70	"	"	"	16.4	"
"	2.60	"	"	"	15.8	"
"	2.50	"	"	"	15.2	"
"	2.40	"	"	"	14.6	"
"	2.30	"	"	"	14.0	"
"	2.20	"	"	"	13.4	"
"	2.10	"	"	"	12.8	"
"	2.00	"	"	"	12.2	"
"	1.90	"	"	"	11.6	"
"	1.80	"	"	"	11.0	"
"	1.70	"	"	"	10.3	"
"	1.60	"	"	"	9.7	"
"	1.50	"	"	"	9.1	"

Commercial sulphate of ammonia contains about 20.8 per cent. of nitrogen, though it varies somewhat in quality. With that per cent. of nitrogen (equivalent to 25.25 per cent. of ammonia),

If quoted at	2.6	cents per pound,	Nitrogen	costs	12.5	cents per pound.
"	2.5	"	"	"	12.0	"
"	2.4	"	"	"	11.5	"
"	2.3	"	"	"	11.1	"
"	2.2	"	"	"	10.6	"
"	2.1	"	"	"	10.1	"
"	2.0	"	"	"	9.6	"

Commercial nitrate of soda averages 95 per cent. of pure sodium nitrate, or 16 per cent. of nitrogen.

If quoted at	2.5	cents per pound,	Nitrogen	costs	15.6	cents per lb.
"	2.4	"	"	"	15.0	"
"	2.3	"	"	"	14.4	"
"	2.2	"	"	"	13.8	"
"	2.1	"	"	"	13.2	"
"	2.0	"	"	"	12.5	"
"	1.9	"	"	"	11.9	"
"	1.8	"	"	"	11.3	"
"	1.7	"	"	"	10.6	"
"	1.6	"	"	"	10.0	"
"	1.5	"	"	"	9.4	"

Commercial Muriate of Potash usually contains 50½ per cent. of "actual potash," or potassium oxide.

If quoted at	2.20 cents per pound,	Potassium Oxide	costs	4.35	cents per lb.
"	2.15	"	"	4.25	"
"	2.10	"	"	4.15	"
"	2.05	"	"	4.06	"
"	2.00	"	"	3.96	"
"	1.95	"	"	3.86	"
"	1.90	"	"	3.76	"
"	1.85	"	"	3.66	"
"	1.80	"	"	3.56	"
"	1.75	"	"	3.46	"
"	1.70	"	"	3.36	"

High Grade Sulphate of Potash, as it is found in the Connecticut market, contains about 49.2 per cent. of actual potash.

If quoted at	2.50 cents per pound,	Potassium Oxide	costs	5.1	cents per lb.
"	2.45	"	"	5.0	"
"	2.40	"	"	4.9	"
"	2.35	"	"	4.8	"
"	2.30	"	"	4.7	"
"	2.25	"	"	4.6	"
"	2.20	"	"	4.5	"
"	2.15	"	"	4.4	"
"	2.10	"	"	4.3	"
"	2.05	"	"	4.2	"
"	2.00	"	"	4.1	"

The Double Sulphate of Potash and Magnesia has about 26½ per cent. of potassium oxide.

If quoted at	1.00 cents per pound,	Potassium Oxide	costs	3.77	cents per lb.
"	1.05	"	"	3.96	"
"	1.10	"	"	4.15	"
"	1.15	"	"	4.34	"
"	1.20	"	"	4.53	"
"	1.25	"	"	4.72	"
"	1.30	"	"	4.90	"

The following table shows the fluctuations in the wholesale prices of a number of fertilizing materials in the New York market, since November, 1892. The price given for each month is the average of the four weekly quotations of that month. Sulphate of ammonia is assumed to contain 20.8 per cent. and nitrate of soda 16.0 per cent. nitrogen, muriate of potash 50½ per cent., high grade sulphate 49.0 per cent. and double manure salt 26.5 per cent. of actual potash.

Wholesale Prices of Fertilizing Materials.

		Cost of Nitrogen at wholesale in						Cost of Potash at wholesale in			Available Phosphoric Acid in Dissolved South Carolina Rock. Cents per pound.
		Dried Blood.									
		Red. Cents per pound.	Black or low grade. Cents per pound.	Azotin or Ammonite. Cents per pound.	Concentrated Tankage. Cents per pound.	Nitrate of Soda. Cents per pound.	Sulphate of Ammonia. Cents per pound.	Muriate of Potash. Cents per pound.	Double Manure Salt. Cents per pound.	High Grade Sulphate of Potash. Cents per pound.	
1892.	November	14.1	13.8	13.7	....	13.7	14.0	3.78	4.77	4.48	3.30
	December	14.6	14.2	14.8	....	13.7	14.0	3.78	4.77	4.48	3.30
1893.	January	16.2	15.8	15.9	12 3	13.8	14.0	3.51	4.25	4.70	3.33
	February	18.5	18.0	17.9	15.7	14.1	14.0	3.56	4.32	4.16	3.09
	March	20.0	19.8	19.6	19.3	14.7	15.6	3.56	4.32	4.16	3.09
	April	18.0	17.7	18.1	19.3	14.6	17.1	3.56	4.32	4.16	3.09
	May	16.2	15.4	16.4	18.3	13.0	17.1	3.56	4.32	4.16	3.09
	June	14.5	14.0	14.8	14.2	11.0	15.9	3.75	4.32	4.16	3.09
	July	13.7	13.1	13.7	14.2	11.1	14.9	3.75	4.32	4.16	3.09
	August	13.5	12.1	13.9	14.2	11.4	15.6	3.75	4.25	4.16	3.09
	September	12.5	12.2	13.2	14.2	11.6	15.9	3.75	4.32	4.16	3.09
	October	16.2	15.3	15.3	17.1	11.9	16.4	3.75	4.32	4.16	3.09
	November	16.6	15.7	16.6	16.3	11.7	16 4	3.74	4.33	4 15	2.09
	December	16.1	15.3	16.1	16.3	11.3	16.4	3.74	4.33	4.15	3.09
1894.	January	15.9	14.7	16.0	15.9	12.0	16.7	3.58	4 30	4.18	3.09
	February	15.9	15.2	15.9	15.4	11.7	18.4	3.71	4.44	4.28	3.09
	March	15.5	14.6	15.5	15.4	13.0	18.5	3.71	4.44	4.28	3.09
	April	14.5	13.9	14.2	13.3	14.0	17.6	3.84	4.54	4.39	2.98
	May	14.5	13.8	14.2	12.2	14.4	16.7	4.13	5.04	4.85	3.00
	June	13.2	12.6	13.1	12.2	14.3	16.7	4.13	5.04	4.85	3.00
	July	12.6	12.6	12.9	12.2	13.8	16.8	4.13	5.04	4.85	3.00
	August	13.3	12.6	13.3	12.3	13.7	17.7	4.13	5.04	4.85	3.09
	September	15.7	14.5	15.4	12.3	13 5	18.3	4.13	5.04	4.85	3.12
	October	15.1	14.4	15.2	12.4	12.9	17.5	4.13	5.04	4.85	3.12
	November	14.1	13.1	14.0	12.3	13.2	16.4	4 13	5.04	4.85	3.00
	December	13.5	12.4	13.1	12.3	12.9	16.0	4.13	5.04	4.85	3.10
1895.	January	12.7	12.2	13.0	12.3	12.1	15.0	3.54	4.24	4.13	3.50
	February	11.9	11 2	....	12.3	11.4	15 0	3.54	4.24	4.13	3.37
	March	12.1	10.5	....	12.3	10.4	15.0	3.59	4.32	4.20	3.37
	April	11.7	10.6	....	12 3	10.3	15.0	3.59	4.32	4.20	3.37
	May	12.1	10.8	....	12.3	10.5	14.3	3.59	4.32	4.20	3.37
	June	11.7	10 9	....	12.3	11.0	13.6	3.59	4.32	4.20	3.37
	July	11.6	10.7	....	12.3	10.9	13.4	3.60	4.32	4.20	3.37
	August	11.5	10.2	....	12.3	10.8	13.1	3.60	4.32	4.20	3.37
	September	11.8	10.2	....	12.3	11.3	13.0	3.60	4.32	4.20	3.23
	October	11.8	10.2	....	12 3	11.7	12.2	3.60	4.32	4 20	2.62
	November	11.7	9.9	....	12.3	11.6	12.0	3.60	4.32	*4.34	2.62
	December	11.7	9.8	....	12 3	11.1	12.0	3 60	4.32	4 34	2.62
1896.	January	11.0	9.8	....	12.3	10.8	11.6	3.60	4.32	4.34	2.62
	February	10.8	9.8	....	12.3	10.7	11.3	3 55	3.99	4.13	2.62
	March	10.8	9.8	....	12.3	10.7	11.5	3.53	3.87	4.05	2.73
	April	10.8	9.8	....	12.3	10.7	11.1	3.60	3 94	4.10	2.73
	May	10.7	9.9	....	12.3	10.9	10.8	3.60	3.94	4.10	2.73
	June	10.5	9.8	....	12.3	10.8	10.8	3.60	3.94	4.10	2.73
	July	10.5	9.8	....	12.6	10.8	10.8	3.60	3.94	4.10	2.73
	August	10.5	9.8	....	11.4	10.8	10.7	3.60	3.94	4.10	2.73
	September	10.2	9.1	....	9.5	10.8	10.5	3.60	3.94	4.10	2.73
	October	10.3	9.0	....	9.5	11.3	10.5	3.60	3.94	4.10	2.73

* Calculated on basis of 49 per cent. potash in the salt.

THE PROPER USE OF TABLES OF ANALYSES OF FERTILIZERS AND FERTILIZER CHEMICALS.

BY E. H. JENKINS.

On page 162 of the Report for 1895 is a paper by the Director of this Station, on The Best Economy of Concentrated Fertilizers.

The paper is designed to illustrate the facts that "the interests of those who buy as well as of those who sell commercial fertilizers can be best promoted by a knowledge, well applied, of all the factors of crop-production; that the plant, like the man, to flourish, not only requires an abundant and varied bill of fare, but also a suitable lodging and the comforts of a well-appointed home; that the best economy of commercial fertilizers is to be attained by intelligently investigating what special wants of the soil or crop their various grades are adapted to meet, and what further wants of soil or crop must be attended to in order to prevent that impoverishment of land and landholder which otherwise, sooner or later, is likely to ensue—the experience of which has led many agriculturists to the erroneous conclusion that concentrated fertilizers are 'stimulants and not nourishment,' and that they 'exhaust the soil,' whereas they merely aid the farmer to exhaust the soil by rapidly removing, in the crops, substances which the soil unaided can supply but slowly or insufficiently and by impairing or destroying one or several of those conditions which are indispensable to plant-production."

This knowledge the farmer can get, partly from books, but in part only by careful and constant observation and experiment on his own land.

He must know, for instance, whether the water supply and drainage and texture of his soil are such that fertilizers can come to effect on his crops; whether his soil is specially deficient in some one ingredient, as lime or potash; and what elements of plant food his several crops take off from his soil, and how much of them he can put back in crop residues and in stable manure.

Only when he knows these things can he make rational use of the analyses of commercial fertilizers and fertilizer chemicals, which are yearly published by this Station.

For it is clear that if his soil is cold and sour because of deficient drainage, or is parched with drought in summer, money spent in any kind of fertilizers is likely to be thrown away.

Again if his soil greatly lacks available nitrogen or potash, his first effort must be to supply these things by heavy dressings of nitrogenous manures or potash fertilizers, and until this is done, it will be of little use to apply phosphoric acid.

The question regarding commercial fertilizers to be settled with the help of this knowledge of his land and cropping is :—

For the given crop, how many pounds per acre of nitrogen, of phosphoric acid and of potash is it wise to apply?

It is in order to supply these three ingredients that commercial fertilizers are used. If these are not lacking in the soil, it is idle to use commercial fertilizers at all.

We will suppose that in the given case the purchaser has decided to use per acre 65 pounds of nitrogen,—20 of it in form of nitrate,—50 of phosphoric acid and 90 of potash.

He is now ready to avail himself of the facts which it is the business of this Station to supply, and which will be found, in part, in the pages of this Report.

In studying the tables of analyses the first question will not be —which brand of factory-mixed goods shows the highest Station valuation or the least difference between cost and valuation, but rather how can this 65 pounds of nitrogen, 50 of phosphoric acid and 90 of potash be bought in the most available forms and at the lowest price? To find this out he does not need to depend on Station "Valuations" for help.

He can *himself* make valuations more accurate *for his special use*, than the Station can make.

There are two reasons for this. The Station Valuations are a general approximation, not for any particular place, but for freight centers throughout the State. The buyer's valuation should be quite accurate for his particular town or village.

Again, the Station Valuations are based on average quotations for six months or a year. The buyer's valuation should be true for the week in which he makes his purchase.

The Station's duty is to show what different articles contain, what their agricultural value under test conditions is, to protect from frauds in fertilizers and to give what general information it can on the subject of fertilization.

It is the buyer's business, not the Station's, to learn what his fertilizers will cost him and in what particular way he can buy cheapest.

Now the 65 pounds of nitrogen, 50 of phosphoric acid and 90 of potash can be bought in one of two ways; either mixed, finely ground and ready to apply at once in commercial "Phosphates," "Superphosphates" and "Special Manures," or separately in form of agricultural chemicals, etc., to be pulverized if necessary, and mixed or applied to the land separately.

In any case, the next thing is to find out the actual cost of nitrogen, phosphoric acid and potash, when bought for cash, each by itself.

This the Station undertakes in order to fix its schedules of valuations and the business man would do the same before purchasing stock of any kind.

The system of valuation is correct in principle, and there is not a successful fertilizer manufacturer in the country who does not resort to it in buying his raw materials.

The system has been misrepresented as being an attempt to indicate what the fair price of a fertilizer is. It is nothing of the sort; but shows, and only claims to show, what the amounts of nitrogen, phosphoric acid and potash contained in a fertilizer would cost *on the average*, for cash, at freight centers in raw materials, unmixed.

This information is of great value as a general guide to buyers.

After twenty years experience under this system it is, however, believed that the progressive farmers of this State are perfectly capable of making valuations to suit their own particular cases, which will be more accurate for their own conditions of market than any which the Station can make.

In what follows it is shown how a valuation or schedule of valuations may be made, accurate for the time and place where made, and how it may be used by the practical farmer.

Nitrogen.

It has been shown on previous pages of this Report, that the materials now in the Connecticut retail market in which *organic nitrogen* is the leading ingredient, are dry fish, cotton seed meal, linseed meal and castor pomace.

(Dried blood is not generally offered at retail; the "tankage" in market—known to the trade as "bone tankage"—is more a phosphatic than a nitrogenous fertilizer.)

No better forms of organic nitrogen exist than the vegetable matters named above.

The experiments made at this Station during the last three years, as well as the experiments of Wagner, previously made in Germany, indicate that the nitrogen of dried blood, and that of cotton seed, linseed and castor pomace are about equally available; and are more available than the nitrogen of fish, bone, or tankage.

Therefore the choice must be determined chiefly by the cost of nitrogen, with due regard also to the mechanical condition of the material.

Linseed meal—screened for fertilizer use—and cotton seed meal are of equal fineness; the linseed drills rather easier because free from lint. Castor pomace is somewhat coarser.

It appears that the cost of nitrogen per pound in these various articles in the spring of 1896 has been as follows:—

	Average.	Extremes.
In Cotton Seed Meal	12.7	11.2–15.5
Linseed Meal	12.9	12.3–13.7
Castor Pomace	17.9	15.6–20.6
Dry Fish	14.5	11.4–16.6

It is seen that organic nitrogen has been obtainable for 13 cents per pound, and that it has cost as low as 11.2 or as high as 18.2 cents, depending on the purchaser's distance from large markets, his care in buying and the use he has made of the Station in testing the quality of the material offered him.

That is, he *may have* saved 7 cents per pound, or $4.55 for 65 pounds of nitrogen, by care in buying the one item of nitrogen.

He may reckon on getting the following quantities of nitrogen, phosphoric acid and potash in every 100 pounds of cotton seed meal, linseed meal, or castor pomace that he buys.

	Nitrogen.	Phosphoric Acid.	Potash.
In Cotton Seed Meal	6.9	2.8	1.8
Linseed Meal	6.6	1.8	1.2
Castor Pomace	4.8	3.0	1.0

But if buying considerable quantities, it will in any case be wise for the purchaser to send samples to the Station for analysis and in *all* cases to buy with a distinct guarantee.

We will assume that he can buy cotton seed meal at $22.00 per ton containing 6.9 per cent. of nitrogen, 2.81 per cent. of phosphoric acid and 1.85 per cent. of potash, in which therefore nitrogen costs him 12.8 cents per pound; and that he chooses this form of organic nitrogen.

The nitrogen of nitrates can only be bought economically in nitrate of soda, at a cost of from 12.7 to 15.0 cents per pound, as appears from the figures given on page 102.

We will assume that he can buy nitrate of soda, containing 16 per cent. of nitrogen, for $45.00 per ton.

Phosphoric Acid.

The two available forms in which this is found in market, practically free from other fertilizer ingredients, are "acid phosphate"—rock phosphate dissolved by oil of vitriol—and "dissolved bone black."

There is no reason to believe that the soluble or "reverted" phosphoric acid in one of these is any more easily available to plants than in the other.

The acid phosphate is the form used by most manufacturers of fertilizers on account of its greater cheapness. It has a tendency, however, to cake or set, especially when mixed with nitrate or potash salts, unless some dry material, like cotton seed or linseed meal, bone dust, or the like is added. Dissolved bone black, however, never sets in this way.

Available (water-soluble and citrate-soluble) phosphoric acid can be bought in dissolved bone black for 6.6 cents per pound.

In acid phosphate it costs considerably less, but for some reason acid phosphate is not commonly sold by retail dealers in Connecticut.

It is, however, extensively used by farmers in other States with excellent results, and can be readily bought in the New York and New Jersey markets at low prices.

In car lots it was laid down at freight centers for $10.60 per ton or less, in the spring of 1896, and if there were demand for it, could probably be retailed for $15 or less per ton, thus making the cost of available phosphoric acid about 4½ to 5c. per pound.

We assume, for the purpose of our illustration, that the purchaser can buy acid phosphate, containing 14 per cent. of available phosphoric acid, for $16.00 per ton.

Potash.

Leaving ashes out of account, the chief sources of potash for agricultural use are imported potash salts, viz: muriate, high grade sulphate and double sulphate.

	Averages.	Extremes.
Potash in Muriate...........costs cents per pound	4.16	3.9–4.3
" " high grade Sulphate.... " "	5.10	4.9–5.2
" " low " " .... " "	5.60	4.9–6.3

Returning now to the assumed case in which the farmer wishes to get 20 lbs. of nitrate nitrogen, 45 lbs. of organic nitrogen, 50 lbs. of available phosphoric acid, 90 lbs. of potash:—

From the data furnished in this Report and the quotations given by dealers, he can calculate very accurately what they will cost laid down at his freight station as follows :—

We assume that he can buy nitrate of soda for $45 per ton, or $2.25 per 100 lbs.; cotton seed meal for $22.00, or $1.10 per 100 lbs.; acid phosphate for $16.00, or 80 cents per 100 lbs.; and muriate of potash for $42.50 per ton, or $2.13 per 100 lbs.

To get 20 lbs. of nitrate nitrogen he needs 125 lbs. of nitrate of soda, costing $2.82.

Forty-five lbs. organic nitrogen require 652 lbs. cotton seed meal, costing $7.17. This quantity of meal also carries about 2.8 per cent. or 18 lbs. of phosphoric acid and 1.8 per cent. or 11 lbs of potash.

To get the remaining 32 lbs. of phosphoric acid will require, say 230 lbs. of acid phosphate, costing $1.84, and the remaining 79 lbs. of potash will require 158 lbs. of muriate, costing $3.36.

125	pounds	Nitrate of Soda, costing............	$2.82
652	"	Cotton Seed Meal "	7.17
230	"	Acid Phosphate "	1.84
158	"	Muriate of Potash "	3.37
1165	"	costing..........................	$15.20

This represents a cost *per ton* of unmixed chemicals of $26.10, with the following composition:

Nitrogen as Nitrates..................	1.71	per cent.
" Organic	4.00	"
Available Phosphoric Acid............	4.30	"
Potash as Muriate....................	7.72	"

The figures which represent the *actual costs of* nitrogen, phosphoric acid and potash in these unmixed chemicals are the careful purchaser's "Schedule of trade values," which he will apply to the ready-mixed goods that are offered to him, viz:

Nitrogen as Nitrates	14 cents.
" Organic	12.8 "
Available Phosphoric Acid	5.8 "
Potash as Muriate	4.2 "

To illustrate: one of the high-grade factory-mixed fertilizers recently analyzed contains:

Nitrogen as Nitrates	2.91 per cent.
" Organic	2.17 "
Available Phosphoric Acid	7.6 "
Potash as Muriate	6.8 "

and costs $38 per ton.

This contains somewhat less nitrogen and potash and a good deal more phosphoric acid than the particular formula of chemicals above given; and on the whole contains per ton more cash value of fertilizer ingredients by about $1.75. Deducting this from $38.00, the cash price, we have $36.25.

This $36.25 is then the price at which the farmer could buy approximately the same amount of chemicals as his formula contains, finely ground, thoroughly mixed, bagged and ready to put on his land.

The difference between $36.25 and the cost, $26.10, of the chemicals unground and unmixed, namely, $10.15, is the price he must pay for having the work of grinding and mixing done for him.

This brings him to the last question of all: Which is the cheaper, to grind and mix myself or have it done for me.

If he is using only small quantities of fertilizer, half a ton or less, or if he does not attend to it till the pressure of spring work is upon him, unquestionably the latter course is cheapest; if the chemicals are, as is often the case, fine and dry, or can be bought milled fine, for only a slight advance, and the amount used is large, it will often pay well to do the mixing at home. No general rule can be given, each farmer must figure and experiment for himself.

In what has been said we have taken for illustration quickly available but also the cheapest forms of nitrogen, phosphoric acid and potash which are on the market.

These are not always the most economical to use.

For instance, muriate of potash on tobacco is fatal to the crop, and the quality of potatoes may be injured by it, so that the higher priced sulphate is used instead.

Again, some soils which are deficient in lime, as well as potash, are more economically supplied with both at once in form of wood ashes, than by separate applications of oyster shell or stone lime and a potash salt.

It is very likely that cotton hull ashes, by reason of the alkali in them, pay better to use on some soils than either the muriate or sulphate of potash, although the actual potash in them costs considerably more.

Where moist land is laid down to grass, fine bone is preferred by many to the more soluble and quickly available forms of nitrogen and phosphoric acid.

There is often great advantage, too, in changing the form of fertilizer from time to time, rather than in dressing the land year after year in the same way. Such a change prevents an undue accumulation in the soil of any one ingredient not assimilated by the crop in considerable quantity. For instance, the use of superphosphate year after year, for a long time, may cause an accumulation of sulphates which, by reducing the amount of carbonate of lime within the soil, or in other ways, may be injurious.

All these points demand the careful attention of the farmer and are matters which each individual must attend to for himself.

To recapitulate:—

1. Before buying fertilizers in any quantity the farmer should decide—from what he can find out about his land and the past and prospective cropping,—how many pounds of nitrogen, phosphoric acid and potash he will use per acre, and whether any particular forms of these ingredients are specially desirable.

This decision, involving as it does, some thought and study, though it may not accurately meet the needs of land and crop, will make clear to him the uses and limitations of fertilizers.

It is what no one can do for him, and it is certainly a great advance over the plan of putting on half a ton or a ton of "fertilizer" or "superphosphate" per acre, regardless of anything but the cost per ton. This last plan, followed by many, is like prescribing half a pint of "medicine" per week for a patient, without naming either dose or drug.

2. Then the farmer should get, from a number of sources, quotations of such fertilizer chemicals as will serve his purpose, with definite guarantees of composition and clear understanding as to rebates in case the goods are not as guaranteed, and in the ways indicated in the preceding pages, calculate what he must pay for the quantities of nitrogen, phosphoric acid and potash that he has decided upon, delivered at his freight station.

3. The purchaser should then reckon what he must pay in cash for an amount of factory-mixed fertilizer that contains nearly the quantities of fertilizer ingredients which he has determined to apply per acre. This cost of the factory-mixed goods will usually be considerably larger than the cost of unmixed chemicals.

This difference in cost between the two is to be offset against the cost to him of possible pulverizing, mixing and bagging the chemicals, and he has lastly to determine which will probably be the cheaper method, all things considered.

EXPERIMENTS ON THE AVAILABILITY OF FERTILIZER-NITROGEN.

By S. W. Johnson, E. H. Jenkins and W. E. Britton.*

These experiments are a continuation of work done in previous years on the same subject, which is described in the Station Reports: 1885, pp. 115–132; 1886, pp. 80–89; 1893, pp. 218–237; 1894, pp. 73–112; 1895, pp. 99–116.

I. On the Availability of Organic and Nitric Nitrogen. Maize-Cultures in Coal Ashes and Peat. 1896.

Pots Nos. 1 to 150.

In 1894 and 1895 we studied the availability of nitrogen in certain nitrogenous materials by vegetation experiments with maize and oats, grown in pots of soil composed of a mixture of anthracite coal ashes with small amounts of peat and carbonate of lime, and supplied with relatively small quantities of nitrogen in various fertilizers. The mixture itself contained only traces of available nitrogen as had been proved by vegetation experiments, but with the added fertilizers it contained all the elements of plant food excepting nitrogen, in excess of the crop requirements.

The availability of nitrogen was measured by the quantity of this element which the crop took from each material tested.

The Apparatus and Method.

These have been described in our Report for 1894, p. 74, and in all points not specially noted in the following pages, the same apparatus and method were used in 1896.

* These investigations were planned, and the results prepared for publication, by the Director and Vice-Director. The filling of the vegetation pots and the care of them during growth has been wholly in Mr. Britton's charge. The analyses of the fertilizers used and of the crops harvested, with the necessary computations, have been made by the station chemists, Messrs. Winton, Ogden and Mitchell.

SOIL AND FERTILIZERS.

For the experiments now to be described, were used the pots and their contents as left at the conclusion of the corresponding trials of 1895, after storage in a very dry cellar during the winter.

Just before planting, in the spring of 1896, the contents of each pot were emptied out. Such roots as had not decayed were pulverized and, together with the fertilizer chemicals, were thoroughly mixed with the soil, which was then filled into the pot again. The pots were provided with a tube for ventilation and water supply as described in the Report of 1894, p. 78, but the layer of fine gravel there mentioned was omitted.

Each pot received 0.25 gram of sodium chloride, 1 gram of magnesium carbonate, 8 grams of calcium carbonate, 5 grams of potassium phosphate and 1 gram of potassium sulphate.

The potassium phosphate contained 52.1 per cent. of potash and 37.48 per cent. of phosphoric acid. The potassium sulphate contained 53.79 per cent. of potash.

The maximum maize crop in the experiments of 1895, pot 117, (Report 1895, p. 85), contained the quantities of ash ingredients or mineral matters named below. Here are also given the quantities of these ingredients added to each pot as fertilizers, in 1896.

	In largest crop of 1895.	In fertilizers, 1896.
Potash	2.96 grams.	3.14 grams.
Soda	.34 "	.14 "
Lime	.88 "	4.48 "
Magnesia	.49 "	.48 "
Chlorine	.56 "	.15 "
Sulphuric acid	.28 "	.46 "
Phosphoric acid	.31 "	1.87 "

The coal ashes themselves, as was proved by vegetation experiments, contained considerable quantities of available potash and phosphoric acid. The soil in each pot was impregnated with a watery infusion of rich garden soil.

The nitrogenous matters tested were in each case a part of the same stock from which last year's tests were made; the slight differences between the percentages of nitrogen found in 1895 and in 1896 being due to changes in water-content.

The nitrogenous materials were as follows:—

Nitrate of soda,	containing	16.15	per cent.	of nitrogen.
Dried Blood,	"	13.54	"	"
Castor Pomace, No. 4546,	"	4.96	"	"
" 4545,	"	4.73	"	"
Cotton Seed Meal,	"	8.30	"	"
Dry Ground Fish,	"	9.64	"	"
Ground Horn and Hoof,	"	15.33	"	"
Bone Tankage,	"	5.10	"	"
Linseed Meal,	"	6.41	"	"

These materials have been more fully described in the Report for 1895. All of them represent commercial articles bought for fertilizer purposes.

The preparations of leather, raw, steamed, roasted and dissolved, are described on page 109 of this Report.

All of the above materials were pulverized to pass circular holes $\frac{1}{50}$ inch in diameter.

The arrangement of the tests and the quantities of nitrogen used are shown in Table I.

Before planting, the pots received the maximum quantity of water which was to be supplied to them during the experiment, together with the soil-infusion already mentioned.

Seed and Planting.

The seed was the Longfellow field maize, a flint variety, each of the selected kernels weighing between 0.40 and 0.44 gram.

The seed was placed in the germinating apparatus on April 18th, and the sprouted seed was planted from April 21st to 24th, in the following way:—

Two pounds of the moist soil were taken from each pot, three seedlings were placed on the smoothed surface of what remained, and the soil that had been removed was put back, thus covering the seeds to a depth of one and a half inches.

The young plants began to appear on April 27th, and all had come up by May 4th. One additional kernel was planted in pot 112, to fill a vacancy.

Care During Growth.

After planting, the pots were removed to the summer vegetation house described in our Report for 1894, p. 76.

The water supply was kept between 80 and 60 per cent. of the water-holding capacity of the soil (see foot note, page 186).

On May 18th, all the plants in pots 13, 135 and 136 were noted as small and unthrifty. In pot 26 one plant was thrifty, the others were apparently dying. Pot 109 had two thrifty-looking plants and one of the same size as the others, but yellow and sickly. Pots 12 and 26 had each one unthrifty plant. At this date the largest plants were about one foot high.

On June 22d, 0.8 gram of nitrogen as nitrate of soda was added to pots 11 and 13, and on July 11th, this amount was again added to pot 13.

At harvest time one of the three plants in each of pots Nos. 7, 12, 14, 26, 109, and 117, was dead. Pot 111 had but one living plant.

Before harvest, staminate flowers appeared on plants in all the pots, but no ears had sufficiently developed to make it possible to take separate account of them.

Harvesting.

The crop was harvested July 21st to 24th. Each stalk was cut close to the soil surface. The roots are not included in the "crop."

The following explanations are referred to by small numerals in their appropriate places in the table:

2. The pot received 0.8 gram at planting time, and 0.8 gram later.
3. The pot received 0.8 gram at planting time and the same quantity at each of two intervals during growth.
4. The water in the pot was kept between 80 and 60 per cent. of the water-holding capacity of the soil.
5. The water in the pot was kept between 70 and 50 per cent. of the water-holding capacity of the soil.
6. The water in the pot was kept between 60 and 40 per cent. of the water-holding capacity of the soil.
7. The water in the pot was kept between 80 and 40 per cent. of the water-holding capacity of the soil.

TABLE I.—VEGETATION EXPERIMENTS, IN COAL ASHES AND PEAT. 1896. AVAILABILITY OF NITROGEN TO MAIZE.

Number of Pot.	Nitrogen supplied— In form of—	Nitrogen supplied— Quantities of Nitrogen supplied. (Grams.)	Crops. Weights of air-dry Crops, exclusive of roots (grams).	Crops. Weights of Water-free Crops, exclusive of roots (grams).	Crop-Nitrogen. Percentages of Nitrogen in the air-dry Crops.	Crop-Nitrogen. Total Nitrogen of Crops, exclusive of roots (grams).
5	Horn and Hoof	.8	78.5	69.0	.47	.369
6	" "	1.6	165.7	147.0	.45	.746
7	" "	2.4	35.5	31.6	2.20	.781
8	" "	3.2	60.4	56.0	1.88	1.136
9	Nitrate of Soda	.8	126.9	111.1	.38	.482
10	" "	1.6	138.3	119.9	.68	.940
11	" "	.8+.8[2]	152.0	138.5	.65	.988
12	" "	2.4	34.8	31.8	2.23	.776
13	" "	.8+.8+.8[3]	32.8	30.5	2.35	.771
14	Dried Blood	.8[4]	52.0	45.5	.56	.291
15	"	1.6[4]	144.2	127.9	.47	.678
16	"	.8[5]	93.7	83.2	.39	.365
17	"	1.6[5]	145.0	128.5	.42	.609
18	"	.8[6]	96.7	84.2	.36	.348
19	"	1.6[6]	137.0	126.3	.48	.658
20	"	.8[7]	99.6	87.2	.38	.378
21	"	1.6[7]	157.9	137.8	.44	.695
23	"	1.6	145.6	128.4	.41	.597
24	"	2.4	127.0	111.8	.64	.813
25	"	2.4	168.3	154.6	.53	.892
26	"	3.2	34.6	31.9	1.87	.647
27	"	3.2	124.5	109.2	.89	1.108
102	Castor Pomace **4545**	.8	79.3	69.1	.44	.349
103	" " "	1.6	142.2	125.8	.42	.597
104	" " "	2.4	145.1	129.2	.59	.856
105	" " "	3.2	171.3	157.2	.88	1.507
106	Castor Pomace **4546**	.8	85.0	74.8	.39	.332
107	" " "	1 6	158.8	141.5	.43	.683
108	" " "	2.4	158.5	144.7	.51	.808
109	" " "	3.2	31.5	28.0	2.39	.753
110	Cotton Seed Meal	.8	76.6	67.3	.42	.322
111	" " "	1.6	10.0	9.0	2.40	.240
112	" " "	2.4	144.3	132.8	.57	.823
113	" " "	3.2	164.1	150.5	.51	.837
114	Dry Fish	.8	94.1	84.4	.39	.367
115	"	1.6	159.4	147.6	.39	.622
116	"	2.4	151.1	139.8	.52	.786
117	"	3.2	157.4	139.7	.55	.866
123	Tankage	.8	85.1	74.1	.35	.298
124	"	1.6	135.2	120.2	.37	.500
125	"	2.4	167.6	149.3	.43	.721
126	"	3.2	206.2	187.3	.54	1.113
127	Linseed Meal	.8	82.9	72.0	.41	.340
128	" "	1.6	153.7	135.9	.38	.584
129	" "	2.4	198.4	181.9	.48	.952
130	" "	3.2	154.8	142.9	.64	.991
135	Raw Leather	.8	1.8	1.6	.71	.013
136	" "	1.6	1.5	1.3	.49	.007
137	Dissolved Leather	.8	47.0	41.3	.58	.273
142	Steamed Leather	.8	26.2	23.1	.42	.110
143	" "	1.6	43.7	40.0	.41	.179
144	" "	2.4	63.9	59.0	.43	.275
145	" "	3.2	59.9	54.7	.45	.270
146	Roasted Leather	.8	7.5	6.6	.47	.035
147	" "	1.6	14.0	12.2	.45	.063

TABLE II.—VEGETATION EXPERIMENTS OF 1894, 1895 AND 1896, IN COAL ASHES AND PEAT. ONE CROP (MAIZE) IN 1894, TWO CROPS (OATS FOLLOWED BY MAIZE) IN 1895, ONE CROP (MAIZE) IN 1896.

AVAILABILITY OF NITROGEN.

Number of Pot.	Source of the Fertilizer-Nitrogen.	Crop raised.	Year.	Quantities of Fertilizer-Nitrogen (grams).	Quantities of Crop-Nitrogen (grams).	Crop-Nitrogen expressed in percentages of Fertilizer-Nitrogen.	Yearly Averages from Figures of preceding column.	Corrected yearly Averages, excluding Figures in brackets.	Corrected Averages for the three years.
5	Horn and Hoof	Maize.	1894	.8	.307	38.4			
6	" "	"	"	1.6	.561	35.1			
7	" "	"	"	2.4	1.015	42.3	38.9	38.9	
8	" "	"	"	3.2	1.278	39.9			
5	" "	Oats and Maize.	1895	.8	.384	48.0			
6	" "	" "	"	1.6	.778	48.6			
7	" "	" "	"	2.4	1.064	44.3	46.2	46.2	41.8
8	" "	" "	"	3.2	1.404	43.9			
5	" "	Maize.	1896	.8	.369	46.1			
6	" "	"	"	1.6	.746	46.6			
7	" "	"	"	2.4	.781	32.5	40.2	40.2	
8	" "	"	"	3.2	1.136	35.5			
9	Nitrate of Soda	Maize.	1894	.8	.384	48.0			
10	" "	"	"	1.6	.867	54.2			
11	" "	"	"	.8+.8	.797	49.8	54.6	50.7	
12	" "	"	"	2.4	1.376	[57.3]			
13	" "	"	"	.8+.8+.8	1.531	[63.8]			
9	" "	Oats and Maize.	1895	.8	.658	82.2			
10	" "	" "	"	1.6	1.284	80.2			
11	" "	" "	"	.8+.8	1.265	79.1	82.2	80.5	63.8
12	" "	" "	"	2.4	1.992	[83.0]			
13	" "	" "	"	.8+.8+.8	2.070	[86.3]			
9	" "	Maize.	1896	.8	.482	60.3			
10	" "	"	"	1.6	.940	58.8			
11	" "	"	"	.8+.8	.988	61.8	49.1	60.3	
12	" "	"	"	2.4	.776	[32.3]			
13	" "	"	"	.8+.8+.8	.771	[32.1]			
22	Dried Blood	Maize.	1894	.8	.334	[41.8]			
23	" "	"	"	1.6	.604	37.7			
24	" "	"	"	2.4	.931	38.8			
25	" "	"	"	2.4	1.030	42.9	40.1	39.8	
26	" "	"	"	3.2	1.287	[40.2]			
27	" "	"	"	3.2	1.261	[39.4]			
22	" "	----	1895	--	----	----			
23	" "	Oats and Maize.	"	1.6	.897	56.0			
24	" "	" "	"	2.4	1.180	49.1			
25	" "	" "	"	2.4	1.289	53.1	45.9	52.7	42.9
26	" "	" "	"	3.2	1.134	[35.4]			
27	" "	" "	"	3.2	1.147	[35.9]			
23	" "	Maize.	1896	1.6	.597	37.3			
24	" "	"	"	2.4	.813	33.9			
25	" "	"	"	2.4	.892	37.2	32.6	36.1	
26	" "	"	"	3.2	.647	[20.2]			
27	" "	"	"	3.2	1.108	[34.6]			

TABLE II.—VEGETATION EXPERIMENTS, ETC.—*Continued.*

AVAILABILITY OF NITROGEN.

Number of Pot.	Source of the Fertilizer-Nitrogen.	Crop raised.	Year.	Quantities of Fertilizer-Nitrogen (grams).	Quantities of Crop-Nitrogen (grams).	Crop-Nitrogen expressed in percentages of Fertilizer-Nitrogen.	Yearly Averages from Figures of preceding column.	Corrected yearly Averages, excluding Figures in brackets.	Corrected Averages for the three years.
102	Castor Pomace No. 4545	Maize.	1894	.8	.351	43.9			
103	" " "	"	"	1.6	.680	42.5			
104	" " "	"	"	2.4	1.211	50.4	45.9	45.6	
105	" " "	"	"	3.2	1.499	[46.8]			
102	" " "	Oats and Maize.	1895	.8	.496	62.0			
103	" " "	" "	"	1.6	.968	60.5			
104	" " "	" "	"	2.4	1.432	59.7	57.4	60.7	48.4
105	" " "	" "	"	3.2	1.519	[47.5]			
102	" " "	Maize.	1896	.8	.349	43.6			
103	" " "	"	"	1.6	.597	37.3			
104	" " "	"	"	2.4	.856	35.7	40.9	38.9	
105	" " "	"	"	3.2	1.507	[47.1]			
106	Castor Pomace No. 4546	Maize.	1894	.8	.315	39 4			
107	" " "	"	"	1.6	.505	31.6			
108	" " "	"	"	2.4	.945	39.4	36.6	36.8	
109	" " "	"	"	3.2	1 148	[35.9]			
106	" " "	Oats and Maize.	1895	.8	.510	63.5			
107	" " "	" "	"	1.6	.931	58.2			
108	" " "	" "	"	2.4	1.348	56.2	52.4	59.3	45.1
109	" " "	" "	"	3.2	1.010	[31.6]			
106	" " "	Maize.	1896	.8	.332	41.5			
107	" " "	"	"	1.6	.683	42.6			
108	" " "	"	"	2.4	.808	33.7	35.3	39.3	
109	" " "	"	"	3.2	.753	[23.2]			
110	Cotton Seed Meal.....	Maize.	1894	.8	.330	41.3			
111	" " "	"	"	1.6	.589	[36.8]			
112	" " "	"	"	2.4	1.126	46.9	40.3	44.1	
113	" " "	"	"	3.2	1.157	[36.1]			
110	" " "	Oats and Maize.	1895	.8	.513	64.1			
111	" " "	" "	"	1.6	.927	[57.9]			
112	" " "	" "	"	2.4	1.232	51.3	52.1	57.7	46.4
113	" " "	" "	"	3.2	1.118	[35.0]			
110	" " "	Maize.	1896	.8	.322	40.2			
111	" " "	"	"	1.6	.240	[15.0]			
112	" " "	"	"	2.4	.823	34.3	28.9	37.3	
113	" " "	"	"	3.2	.837	[26.1]			
114	Dry Fish............	Maize.	1894	.8	.297	37.1			
115	"	"	"	1.6	.531	33.2			
116	"	"	"	2.4	.929	[38.7]	35.5	35.2	
117	"	"	"	3.2	1.062	[33.2]			
114	"	Oats and Maize.	1895	.8	.423	52.9			
115	"	" "	"	1.6	.905	56.6			
116	"	" "	"	2.4	.861	[35.8]	44.0	54.8	44.1
117	"	" "	"	3.2	.988	[30.9]			
114	"	Maize.	1896	.8	.367	45.9			
115	"	"	"	1.6	.622	38.9			
116	"	"	"	2.4	.786	[32.8]	36.2	42.4	
117	"	"	"	3.2	.866	[27.1]			

TABLE II.—VEGETATION EXPERIMENTS, ETC.—*Concluded.*

AVAILABILITY OF NITROGEN.

Number of Pot.	Source of the Fertilizer-Nitrogen.	Crop raised.	Year.	Quantities of Fertilizer-Nitrogen (grams).	Quantities of Crop-Nitrogen (grams).	Crop-Nitrogen expressed in percentages of Fertilizer-Nitrogen.	Yearly Averages from Figures of preceding column.	Corrected yearly Averages, excluding Figures in brackets.	Corrected Averages for the three years.
123	Tankage	Maize.	1894	.8	.282	35.3			
124	"	"	"	1.6	.590	36.9			
125	"	"	"	2.4	1.024	42.7	37.2	37.2	
126	"	"	"	3.2	1.077	33.7			
123	"	Oats and Maize.	1895	.8	.360	45.0			
124	"	" "	"	1.6	.607	37.9			
125	"	" "	"	2.4	1.102	45.9	43.9	43.9	38.2
126	"	" "	"	3.2	1.502	46.9			
123	"	Maize.	1896	.8	.298	87.3			
124	"	"	"	1.6	.500	31.3			
125	"	"	"	2.4	.721	30.0	33.4	33.4	
126	"	"	"	3.2	1.113	34.8			
127	Linseed Meal	Maize.	1894	.8	.330	41.2			
128	" "	"	"	1.6	.635	39.7			
129	" "	"	"	2.4	.755	31.5	35.2	37.5	
130	" "	"	"	3.2	.909	[28.4]			
127	" "	Oats and Maize.	1895	.8	.439	54.9			
128	" "	" "	"	1.6	.987	61.7			
129	" "	" "	"	2.4	1.290	53.8	50.1	56.8	44.6
130	" "	" "	"	3.2	.934	[29.9]			
127	" "	Maize.	1896	.8	.340	42.5			
128	" "	"	"	1.6	.584	36.5			
129	" "	"	"	2.4	.952	39.7	37.4	39.6	
130	" "	"	"	3.2	.991	[30.9]			
135	Raw Leather	Maize.	1894	.8	.014	1.8	1.1	1.1	
136	" "	"	"	1.6	.009	.5			
135	" "	Oats and Maize.	1895	.8	.020	2.5	1.6	1.6	1.2
136	" "	" "	"	1.6	.011	.7			
135	" "	Maize.	1896	.8	.013	1.6	1.0	1.0	
136	" "	"	"	1.6	.007	.4			
137	Dissolved Leather	Maize.	1894	.8	.308	38.5	38.5	38.5	
137	" "	Oats and Maize.	1895	.8	.408	51.0	51.0	51.0	40.8
137	" "	Maize.	1896	.8	.273	32.9	32.9	32.9	
142	Steamed Leather	Maize.	1894	.8	.047	5.9			
143	" "	"	"	1.6	.053	3.3			
144	" "	"	"	2.4	.088	3.7	4.1	4.1	
145	" "	"	"	3.2	.116	3.6			
142	" "	Oats and Maize	1895	.8	.081	10.1			
143	" "	" "	"	1.6	.136	8.5			
144	" "	" "	"	2.4	.205	8.5	8.8	8.8	8.0
145	" "	" "	"	3.2	.267	8.3			
142	" "	Maize.	1896	.8	.110	13.8			
143	" "	"	"	1.6	.179	11.2			
144	" "	"	"	2.4	.275	11.4	11.2	11.2	
145	" "	"	"	3.2	.270	8.4			
146	Roasted Leather	Maize.	1894	.8	.040	5.0	4.7	4.7	
147	" "	"	"	1.6	.071	4.4			
146	" "	Oats and Maize.	1895	.8	.062	7.8	8.2	8.2	5.7
147	" "	" "	"	1.6	.135	8.5			
146	" "	Maize.	1896	.8	.035	4.4	4.2	4.2	
147	" "	"	"	1.6	.063	3.9			

Discussion of Tables I and II.

The Water Supply.

In pots 14 and 15, Table I, the water in the soil was maintained between 80 and 60 per cent. of the water-holding capacity of the soil;* in pots 16 and 17 between 70 and 50 per cent.; in pots 18 and 19 between 60 and 40 per cent., and in pots 20 and 21 between 80 and 40 per cent.

In the other pots, the water-supply was maintained between 80 and 60 per cent., but was to be changed at any time, according to the indications of pots 14 to 21.

There was no apparent difference in the development of the crops in pots 14 to 21. The results given in Table I show, however, that the largest assimilation of nitrogen took place in pots 20 and 21, whose water-supply was maintained between the limits of 80 and 40 per cent. of the water-holding capacity of the soil. The assimilation of nitrogen was nearly ten per cent. larger in pots 20 and 21 than in pots 14 and 15.

Availability of the Fertilizer-Nitrogen.

The weight of dry matter in the crops is not a measure of the availability of fertilizer-nitrogen. This is true of tests in the field as well as of those in pots. Wherever the conditions of growth are unbalanced, the individual plants are likely to vary greatly in composition; some producing relatively little vegetable matter having a high percentage of nitrogen; others producing much, with a low content of nitrogen. In the experiments under discussion, one at least of the factors of growth, the nitrogen supply, was necessarily unfavorable to full crop production, for, in order to compare the relative effect of different forms of nitrogen, they must be used in quantities not sufficient to meet the requirements of a maximum crop.

In consequence, and possibly because of other unfavorable conditions—limited size of pots, crowding of plants, etc.—the crops in this series of tests vary widely in their percentage of nitrogen.

To illustrate:—as shown in Table I, the soils of pots 5, 6, 7 and

* The quantity of water which the perfectly saturated soil in a vegetation pot retains, measures the "water-holding capacity" of this soil. In these experiments this quantity of water was 3892 grams or 8.58 pounds. 80 per cent. of this is 3113 grams, or 6.86 pounds.

8 received 0.8, 1.6, 2.4 and 3.2 grams of nitrogen respectively. The weights of dry matter harvested were 69, 147, 31.6 and 56.0 grams respectively, weights which give no clue whatever to the availability of the fertilizer-nitrogen.

The last column of the table, however, states the actual quantities of fertilizer-nitrogen taken from the soil by the several crops.

These quantities are 0.369, 0.746, 0.781 and 1.136 grams.* From them we reckon that in the four tests, 46.1, 46.6, 32.5, and 35.5 per cent. respectively of the fertilizer-nitrogen were taken up by the plants.

These figures give a basis for calculating the relative availability of the several forms of nitrogen.

We shall therefore consider only the quantities of nitrogen which the crops (exclusive of roots) took from the soil.

Table II gives a complete view of all the results obtained during the three years 1894, 1895 and 1896.

A considerable number of experiments made with Dried Blood as a source of nitrogen, to study the effect of increased or diminished water-supply, etc. are omitted from Table II because they are not strictly comparable with the others.

Certain figures in the table are inclosed in brackets and excluded from the general average. This has been done wherever it was evident, either during the growth of the crop, or on inspection of the weights of nitrogen harvested, that something had interfered with the proper development of the crop. The chief damage to the plants appears to have resulted from rapid decay of the organic matter of the fertilizers. This occurred where the larger quantities were used. It is probable that the roots were injured, and possibly a portion of the nitrogen of the decaying matter escaped in the free state, or otherwise became useless to the growing crop. But no such injury was observed where slowly available forms of nitrogen, as bone tankage or steamed leather, were employed. The experiments of three years have proved that, for the volume of soil which was used in these tests, 3.2 grams of nitrogen, in quickly decaying form, is more than can be safely

	Pot No. 5	Pot No. 6	Pot No. 7	Pot No. 8
* The Fertilizer-nitrogen ratios are as..	10	20	30	40
Dry crop ratios are as	10	21	5	8
Crop-nitrogen ratios are as......	10	20	21	31

employed and make probable that 2.4 grams is an excessive quantity.

In the column headed "Crop-Nitrogen expressed in per cent. of Fertilizer-Nitrogen" (Table II), we have a set of figures, obtained, in the first instance (pot 5), by the arithmetical proportion 0.8:100::0.307:38.4, which signifies that of 100 parts of fertilizer-nitrogen, in this case supplied by horn and hoof, 38.4 parts have been taken into the crop which was harvested from that pot.

The "crop," be it remembered, does not include roots.

Now the crop-nitrogen expressed in per cent. of the fertilizer-nitrogen (which in this paper we shall call the "per cent. availability") is not the same for the three years.

For example, as is shown in Table II, the average per cent. availability of nitrogen in Horn and Hoof was 38.9 in 1894, 46.2 in 1895, and 40.2 in 1896. These differences are no doubt caused in part by the different amounts of heat and light which the plants received in these three years, and also by the fact that two crops, oats and maize, were grown in 1895, and but one crop, maize, in 1894 and also in 1896.

Hence it would appear that, if the per cent. availability found in any single crop in one year is excluded from the average, the per cent. for each of the other years in the corresponding crop, should also be excluded in order to give the results of each season their true relative value in the average.

The column headed, "Yearly Averages from figures of preceding column," gives the average of *all* the figures from the preceding column, *including those inclosed in brackets.*

For reasons just mentioned, the figures in brackets are excluded from the "corrected averages," which are stated in the last two columns. It will be noticed that the greatest difference between the mean of the "yearly averages" and that of the "corrected yearly averages" occurs in case of Cotton Seed Meal, and amounts to 6.0 per cent. The other differences are for Dry Fish, 5.5; Linseed Meal 3.7; Castor Pomace No. **4546**, 3.7; Blood 3.4; Nitrate of Soda 1.8; Castor Pomace, No. **4545**, 0.3 per cent.; while there is no difference in case of horn and hoof, tankage and the preparations of leather.

It will be observed that in every case, except where the source of nitrogen was steamed leather, a larger proportion of the fertilizer-nitrogen was taken up in 1895 than in either 1894 or 1896. This is due to the fact that in 1895 two crops were grown in

each pot, oats followed by maize. The oat crops in those pots receiving the larger quantities of nitrogenous matter were in some cases badly damaged by the rapid decay of the fertilizer, but the following maize crop took up available nitrogen which the damaged oat crops could not assimilate.

In Table III is given a summary, showing for the years 1894, 1895 and 1896, both the Percentage Availability of Nitrogen in the materials tested and also the Nitrogen Availability in Percentage of that of nitrate of soda.

The percentage availability of nitrogen in any material may be expected to differ in different years, for reasons which have been noted above.

It is not so obvious why the nitrogen-availability reckoned on nitrate should differ so considerably from year to year, as appears in some cases in the table.

TABLE III.—PERCENTAGE AVAILABILITY OF NITROGEN.

	To Maize, 1894.		To Oats & Maize, 1895.		To Maize, 1896.	
	Percentage Availability of Nitrogen.	Availability in Percentage of that of Nitrate.	Percentage Availability of Nitrogen.	Availability in Percentage of that of Nitrate.	Percentage Availability of Nitrogen.	Availability in Percentage of that of Nitrate.
Horn and Hoof	38.9	76.7	46.2	57.4	40.2	66.6
Nitrate of Soda	50.7	100.0	80.5	100.0	60.3	100.0
Dried Blood	39.8	78.5	52.7	65.5	36.1	59.9
Castor Pomace, No. 4545	45.6	89.9	60.7	75.4	38.9	64.5
Castor Pomace, No. 4546	36.8	72.6	59 3	73.6	39.3	65.1
Cotton Seed Meal	44.1	86.9	57.7	71.7	37.3	61.8
Dry Fish	35.2	69.4	54.8	68.0	42.4	70.3
Tankage	37.2	73.3	43.9	54.5	33.4	55.4
Linseed Meal	37.5	73.9	56.8	70.5	39.6	65.6
Raw Leather	1.1	2.1	1.6	1.9	1.0	1.6
Dissolved Leather	38 6	75.9	51.0	63.4	32.9	54.5
Steamed Leather	4.1	8.1	8.8	10.9	11.2	18.5
Roasted Leather	4 7	9.2	8.2	10.2	4.2	7.0

In Table IV is given the nitrogen-availability reckoned on nitrate, as found severally in the experiments of 1894, in the combined average of 1894 and of 1895, and lastly, in the average of all three years.

It is to be observed in Table IV, that while the results of 1894, in case of one-half of the fertilizers, differ by 6 to 10 per cent:

from those of 1894 and 1895 averaged together, the combined averages of 1894 and 1895 are but little altered by the results of 1896, as seen by comparing the last two columns.

Whether this increasing agreement is a consequence of the impregnation of the coal ashes and peat with microbes, or is accidental, can only be determined by further investigation.

TABLE IV.—NITROGEN-AVAILABILITY RECKONED ON NITRATE.

	Experiments of 1894.	Experiments of 1894 and 1895.	Experiments of 1894, 1895 and 1896.
Nitrate of Soda	100	100	100
Collier Castor Pomace, No. 4545	90	83	77
Cotton Seed Meal	87	79	74
Red Seal Castor Pomace, No. 4546	73	73	70
Linseed Meal	74	72	70
Dried Blood	79	72	68
Dry Fish	69	69	69
Dissolved Leather	76	70	65
Horn and Hoof	77	67	67
Tankage	73	64	61
Steamed Leather	8	10	13
Roasted Leather	9	10	9
Raw Leather	2	2	2

The availability of the nitrogen of roasted, steamed and raw leather, while not alike in the three years, is so much lower than that of any other materials tested, as to demonstrate that the nitrogen in them is comparatively inert and of little effect unless applied in large quantities.

The experiments also demonstrate that leather may be dissolved in oil of vitriol so as to make its nitrogen nearly as available to the maize and oat crops as that of tankage. Samples of roasted leather, steamed leather and dissolved leather were prepared each year from a common stock of raw leather, and slight differences in their preparation might explain the differences of availability observed in different years.

Of the nine materials tested, other than leather, tankage certainly has the lowest nitrogen-availability, ranking 7th, 9th and 9th in the three years tests.

Regarding the nitrogen-availability of the other organic matters the experiments are not altogether conclusive.

II. A Comparison of Nitrogen-Availability Determined by Vegetation Experiments and Nitrogen-Solubility in Chemical Reagents, 1896.

Pots 246–277.

Former Investigations.

The solubility in pepsin-hydrochloric acid [Artificial Digestion] of different forms of organic nitrogen was first proposed by Stutzer and Klinkenberg as a measure of the availability of such nitrogen to plants.—*Jour. für Landw.*, 1882, p. 363.

C. U. Shepard and P. Chazal applied artificial digestion to forms of nitrogen used in this country, and it was more fully studied by this Station. The conclusions drawn were as follows (Report 1885, p. 130):

"1. The nitrogen of dried blood, red and black (4 samples), cotton seed (4 samples), castor pomace and maize refuse (each one sample) was in every case soluble in pepsin solution, by 24 hours digestion, to the extent of 75 per cent. or more.

2. The nitrogen of fish (10 samples), dried animal matter (tankage, horse-meat, etc., 3 samples) and of bone (20 samples) was in every case soluble to the extent of over 52 per cent.

3. The nitrogen of leather, steamed or extracted by benzine, was in no case soluble to the extent of over 36 per cent. The nitrogen of horn shavings, horn dust, ground horn and hoof, bat guano, felt waste and wool waste was considerably less soluble than the nitrogen of leather.

4. This method divides all organic nitrogenous matters into two classes according to the digestibility of their nitrogen. In one class more than half of the nitrogen, in the other scarcely more than one-third is digestible. To the first class belong all whose nitrogen is known to be readily "available;" in the second class the most digestible are leathers variously manipulated which are known to be almost valueless as fertilizers. To some extent this method is, therefore, a measure of the agricultural value of nitrogen. How far it is a correct measure must be determined by vegetation experiments under accurately controlled conditions in which nitrogen is supplied in substances that have been tested by digestion experiments.

In the meantime the method has decided value because in

many cases it will distinguish between available and inert nitrogen in mixed fertilizers."

At the same time the method of determining nitrogen-solubility by putrefactive fermentation as proposed by Morgen, *Landw. Versuchs.-St.* 1880, p. 50, was also examined, and the conclusion was reached that "this test of putrefaction draws the same line between the two classes that was drawn by the pepsin digestion."

In the Report of this Station for 1893, p. 218, the methods just named were further studied and compared, and the same nitrogenous matters which had been tested by these methods were also tested by vegetation experiments in which the comparative availability of their nitrogen to maize was determined by cultures in soil containing the several fertilizers.

The conclusion of this investigation was: "It is evident that the tedious vegetation-cultures are the only true test of the availability of organic nitrogen, while the pepsin-digestion may give useful indications, but cannot be depended on for decisive results."

Investigations of 1896.

This work was done in coöperation with Mr. J. P. Street, of the New Jersey Station, Reporter on Nitrogen for the Association of Official Chemists, and Mr. R. J. Davidson of the Virginia Station.

Late in April last this Station received from Mr. Street five samples of nitrogenous superphosphates for investigation as to the availability of their nitrogen.

These superphosphates had the following composition :—

No.	4	5	6	7	8
Nitrogen in form of	Blood.	Tankage.	Horn and Hoof.	Raw Leather.	Commercial Fertilizer.*
Nitrogen	2.88	2.98	2.68	2.57	2.15
Total Phosphoric Acid	10.01	9.44	10.30	6.98	11.50
Available Phosphoric Acid	8.26	7.74	8.40	5.92	8.21
Potash soluble in water	7.86	7.86	7.86	7.86	6.04

The solubility of the nitrogen of these fertilizers in pepsin-hydrochloric acid, was determined by us and also the availability of the nitrogen to the maize crop.

* Suspected of containing nitrogen in inferior form.

Solubility of Nitrogen in Pepsin Solution.

The method followed was essentially the same as that used in our experiments of previous years, and is as follows :—

Bring one gram of the material, which has been washed on a filter with cold water, into a 150^{cc} flask, and add 100^{cc} of pepsin-hydrochloric acid solution.* Place the flask, loosely corked, in a water-bath having a constant temperature of 40° C. Keep at this temperature for twenty-four hours, adding 2^{cc} of a ten-per cent. hydrochloric acid solution at the end of the 2d, 5th, 8th and 11th hours. Shake the mixture well on each addition of acid. At the end of the digestion transfer the contents of the flask to a filter, wash with 150 to 200^{cc} of cold water, and determine nitrogen in the residue by the Kjeldahl method.

The percentages of the total nitrogen of these fertilizers which dissolve by use of this method are given in the following table, together with the results obtained by Messrs. Street and Davidson, which have been kindly communicated by Mr. Street.

PERCENTAGE SOLUBILITY OF NITROGEN IN PEPSIN-HYDROCHLORIC ACID.

Sample No.	4	5	6	7	8
Form of nitrogen.	Blood.	Tankage.	Horn and Hoof.	Raw Leather.	Unknown.
Per cent. solubility determined by					
Street	94.2	77.3	56.6	18.7	51.7
Davidson	88.4	73.9	41.5†	13.8	50.5
This Station	94.8	78.5	56.3	17.5	58.1
Average	92.5	76.6	56.5	16.7	53.4

Availability of Nitrogen to the Maize Crop.

This we undertook to determine by vegetation experiments.

The pots used were of galvanized sheet iron, 7 inches in diameter and 9 inches deep. They have been described in the Report of this Station for 1893, p. 231.

The soil used in each pot was six pounds of a mixture of 97 parts by weight of air-dry anthracite coal ashes and 3 parts of air-dry peat (described in the Report for 1893, p. 231). To this were added in each case 5 grams of calcium carbonate, and

* Made by dissolving 5 grams of Parke & Davis' pulverized pepsin (guaranteed to dissolve 2,000 times its weight of coagulated egg albumin) in $1,000^{cc}$ of two-tenths per cent. hydrochloric acid.

† Omitted from average.

the quantity of the fertilizer to be tested, which is given in the following table. After the whole was thoroughly mixed it was filled into the pot and gently packed.

As soon as the pots were filled they were watered, and during the whole experiment, by frequent weighing and watering, the amount of water was kept between 60 and 80 per cent. of the water-holding capacity of the soil.*

On June 2d three kernels of Longfellow maize were planted about 1¼ inches deep in each pot.

These pots stood in the vegetation house during the summer, and the crops were harvested on Sept. 1st and 2d.

No great difference in the development of the crops raised on fertilizers Nos. 4, 5, 6 or 8 was apparent during the season. Those grown with no added nitrogen, see Table V, and those grown with leather, were, of course, very small and backward in development.

The plants raised with fertilizers Nos. 4 and 5 averaged 48 and 47 inches in height respectively, flowered and bore a number of undeveloped ears at harvest time.

The plants grown with fertilizers Nos. 6 and 8 averaged 42 and 44 inches in height and were a little less fully developed than those before mentioned.

The plants grown with leather were about 26 inches high, those to which no nitrogen was given were 25 inches high. Both had some abortive tassels.

The results of this experiment appear in Table V. The eighth column of the table is "Nitrogen Increase," which is reckoned from the seventh column by subtracting from the weight of the crop-nitrogen, in each case, the nitrogen (0.059 grams) which was probably derived from soil and seed and not from the fertilizer, as is indicated in the crops from pots 273 to 276.

The last two columns show what part per hundred of the nitrogen in each fertilizer was actually taken up by the growing maize.

It appears that the per cent. availability of the five fertilizers, under the conditions of our experiment, was as follows:—

* See foot-note, page 186.

TABLE V.—VEGETATION EXPERIMENTS, 1896, WITH NITROGENOUS SUPERPHOSPHATES. AVAILABILITY OF NITROGEN TO MAIZE.

Number of Pot.	Nitrogen supplied— In form of—	Quantities of Nitrogen supplied (grams).	Crops harvested (exclusive of roots). Weights of air-dry Crops (grams).	Weights of Water-free Crops (grams).	Percentages of Nitrogen in air-dry Crops.	Total Nitrogen of Crop (grams).	Nitrogen Increase.	Nitrogen Increase expressed in percentages of Fertilizer-Nitrogen.	
251	No. 4, Blood	.5	70.8	62.16	.40	.283	.224	44.8	46.5
252	" "	.5	83.7	72.98	.36	.301	.242	48.4	
253	" "	1.0	118.4	101.99	.43	.509	.450	45.0	
254	" "	1.0	111.6	95.34	.48	.536	.477	47.7	
255	No. 5, Tankage	.5	78.5	69.10	.35	.275	.216	43.2	44.8
256	" "	.5	93.3	80.91	.33	.308	.249	49.8	
257	" "	1.0	125.7	108.45	.43	.541	.482	48.2	
258	" "	1.0	101.7	88.94	.43	.437	.378	37.8	
259	" "	2.0	141.0	125.36	.77	1.086	1.027	51.3	
260	No. 6, Horn and Hoof	.5	76.1	66.22	.35	.266	.207	41.4	43.4
261	" " "	.5	75.0	66.03	.34	.255	.196	39.2	
262	" " "	1.0	117.8	102.18	.44	.518	.459	45.9	
263	" " "	1.0	112.7	96.74	.47	.530	.471	47.1	
264	" " "	2.0	132.1	117.93	.66	.872	.813	40.6	
265	No. 7, Leather	.5	20.8	18.07	.36	.074	.015	3.0	3.4
266	" "	.5	21.7	18.91	.34	.074	.015	3.0	
267	" "	1.0	24.3	21.51	.41	.100	.041	4.1	
268	" "	1.0	26.0	22.54	.36	.094	.035	3.5	
269	No. 8, Suspected Commercial Fertilizer	.5	58.2	51.59	.36	.210	.151	30.2	29.8
270		.5	60.1	53.19	.33	.198	.139	27.8	
271	" " "	1.0	95.3	82.28	.36	.343	.284	28.4	
272	" " "	1.0	96.4	82.90	.40	.386	.327	32.7	
273	No Nitrogen added	....	16.6	14.51	.32	.053	....	....	
274	" " "	....	18.4	16.00	.34	.063	....	....	
275	" " "	....	17.2	15.00	.35	.060	....	....	
276	" " "	....	16.2	14.21	.38	.062	....	....	

	Per cent. Availability.
No. 4, Blood	46.5
No. 5, Tankage	44.8
No. 6, Horn and Hoof	43.4
No. 7, Leather	3.4
No. 8, Source of nitrogen unknown	29.8

These figures represent the comparative fertilizing value of the nitrogen in these several forms to the maize crop.

It would have been very desirable to increase the number of

tests so as to duplicate the results, but the work was first proposed after other experiments had been begun that took up most of the available space in our summer vegetation house.

Comparison of Results of Maize Cultures with those of Laboratory Methods.

On page 193 have already been given the results of digestion with pepsin-hydrochloric acid.

Mr. Street has also tried the treatment with potassium permanganate, as indicated in Bull. 47, Division of Chemistry, U. S. Dept. Agriculture, p. 115.

In the following statement by Mr. S. H. T. Hayes, the results obtained by Messrs. Street, Davidson and ourselves are presented, reduced to a common basis for comparison.

The per cent. availability of nitrogen as determined by maize cultures in preparation No. 4, was in round numbers 47.

Its per cent. digestibility in pepsin-solution, as has been stated on page 193, is 93.

If now we call its per cent. digestibility 47, to agree with the per cent. availability, and reduce the other figures for pepsin digestibility in the same ratio, we have a set of numbers which show how the relative solubility and digestibility compare with relative availability, as fixed by maize cultures.

	Availability by Maize Cultures.	Digestibility in Pepsin-hydrochloric Acid.	Solubility in Potassium permanganate solution. Acid.	Alkaline.
No. 4, Blood	47	47	47	47
No. 5, Tankage	45	39	45	43
No. 6, Horn and Hoof	43	28	42	52
No. 7, Leather	3	8	14	25
No. 8, Source of nitrogen unknown	30	27	34	33

In these cases the treatment with an acid solution of potassium permanganate has given the closest approximation to the results of maize cultures. The method of treatment with permanganate is thus described by Mr. Street:

Weigh one gram of material into a 500^{cc} flask and add 100^{cc} of permanganate solution. Connect with distilling apparatus and digest for one hour over a low flame without boiling and then distil for one hour. Titrate the distilled ammonia in the usual manner. The alkaline permanganate solution is made by

dissolving 16 grams of potassium permanganate and 200 grams of potassium hydrate in one liter of water. The acid solution was made by dissolving 16 grams of permanganate in one liter of ten per cent. sulphuric acid. When the acid solution is used it is necessary after the preliminary digestion to add sufficient alkali, about 50^{cc} of strong sodium hydrate, to liberate the ammonia.

We believe these chemical methods are of very great value in the examination of mixed fertilizers, as ready tests of the presence of inferior forms of nitrogen. At present, the actual agricultural value of a form of nitrogen cannot, however, be fixed without vegetation experiments.

III. On the Availability of Nitrogen in Bone of Different Degrees of Fineness. 1896.

Pots Nos. 277 to 298.

Preliminary Experiment with Oats.

Pots.

The pots used in these cultures were of stout galvanized iron, 9¾ inches in diameter and 20 inches long, open at both ends. To avoid rusting they were painted with asphalt.

These pots were sunk in the soil of a lawn to within two inches of their upper edges, and were disposed in rows 3½ feet apart, the distance between pots in the same row being 3 feet, measuring in both cases from center to center. The rows were so arranged as to form a quincunx pattern, thus:

```
o     o     o     o
   o     o     o
o     o     o     o
```

Soil and Fertilizers.

The soil was taken in October, 1895, from the Station grounds, under turf which had not been broken up for at least fourteen years, nor received either manure or chemicals for nine years.

The soil was thoroughly mixed, sifted through a screen with four meshes to the inch, and then filled into the 48 pots, which were allowed to stand over winter, uncovered, that the soil might settle naturally under the action of frost and water.

In April, 1896, the soil of each pot received 6½ grams of an acid phosphate containing 11.69 per cent. of water-soluble, 2.59 of citrate-soluble and 1.13 per cent. of acid-soluble phosphoric acid.

There were also added 10 grams of precipitated calcium carbonate and 5 grams of a mixture of sulphate of potash, double sulphate of potash and magnesia, and muriate of potash, which contained 47.38 per cent. of potash.

These fertilizers were in each case thoroughly mixed with 20 pounds of the moist soil (which represented a depth of six inches), taken from the pot for the purpose, and then carefully replaced. The soil of each pot was known to be quite deficient in available nitrogen, but was believed to contain all other ingredients of plant food in comparative abundance.

Planting and Harvesting.

Fifteen selected seed oats, germinated in the seed-testing apparatus, were placed on the surface of the soil in each pot and covered one inch deep with three pounds of the same kind of unfertilized soil which had been used in the first filling.

The planting was done on April 28th to April 30th, and plants had appeared in all the pots on May 5th.

The soil was watered from time to time during the growing season as appeared to be necessary.

The oats grew well and were harvested on July 3d, at which time the plants were ripening and the lower leaves withering, the seeds being in most cases just past the milk stage. The soil was loosened, the roots were taken up as completely as possible and the adhering soil carefully washed off. The crops, including the roots, were air-dried, weighed and their nitrogen was determined.

The oat crops were designed to deplete the soil of its available nitrogen and incidentally to show what accordance might be attained in duplicate experiments made under the conditions here existing.

The results are given in Table VI.

In 27 out of the 48 pots one or more plants remained undeveloped or died, and in only six was there any increase in the number of stalks by tillering.

In no case was the average height of the crop more than 27 inches. These facts indicate the poverty of the soil in available nitrogen.

The nitrogen determinations show that the percentage of nitrogen found in the crops was fairly uniform with exception of Nos. 313 and 324. The average percentage, excluding these, is 0.76, and the widest range is from 0.65 to 0.90 per cent.

TABLE VI. PRELIMINARY OAT CULTURES.

Number of Pot.	Development of the Oat Crops. Number of stalks.	Average height (inches).	Number of stalks headed.	Air-dry weights (grams).	Percentages of Nitrogen in air-dry Crops.	Total Nitrogen (grams).
277	15	24	15	21.6	.73	.158
278	14	22	14	18.0	.71	.128
279	15	22	15	20.0	.75	.150
280	9	21	8	18.7	.75	.140
281	11	26	8	21.8	.75	.163
282	15	24	15	23.4	.73	.171
283	14	21	14	17.9	.67	.120
284	14	23	14	22.5	.68	.153
285	15	22	14	26.7	.73	.195
286	11	20	3	19.0	.90	.171
287	12	22	9	22.2	.81	.180
288	13	23	12	22.6	.76	.172
289	14	21	14	19.2	.75	.144
290	15	21	15	19.8	.73	.145
291	13	20	10	14.9	.81	.121
292	12	21	12	15.9	.81	.129
293	13	22	13	17.5	.75	.131
294	11	23	8	17.9	.83	.149
295	15	21	15	21.7	.76	.165
296	14	22	14	18.7	.73	.137
297	15	21	15	19.9	.71	.141
298	15	20	14	20.7	.75	.155
299	10	23	10	19.5	.77	.150
300	14	21	14	21.4	.71	.152
301	15	21	15	21.4	.69	.148
302	15	24	15	26.6	.65	.173
303	15	22	14	23.4	.76	.178
304	12	26	9	28.2	.78	[.220]
305	15	19	6	21.7	.87	.189
306	14	21	13	21.7	.78	.169
307	16	21	14	24.7	.81	.200
308	15	23	15	21.9	.73	.160
309	14	21	13	20.4	.80	.163
310	12	24	6	19.1	.88	.168
311	16	23	16	25.7	.72	.185
312	14	22	14	23.1	.77	.178
313	10	18	6	11.1	1.46	[.162]
314	14	24	14	30.4	.76	[.231]
315	15	21	15	21.9	.78	.171
316	12	21	9	14.5	.85	.123
317	13	21	13	22.3	.73	.163
318	14	21	14	32.5	.71	[.231]
319	15	21	15	22.5	.78	.176
320	17	27	17	50.9	.68	[.346]
321	14	24	14	24.2	.71	.172
322	32	24	19	84.0	.74	[.621]
323	16	22	6	26.8	.77	.206
324	17	20	1	20.4	1.87	[.381]

Nos. 313 and 324 contained an excessive percentage of nitrogen, associated in 324 with high nitrogen assimilation, but in 313 with half the average yield of vegetable matter.

The yield of air-dry matter and of nitrogen in six crops, 304, 314, 318, 320, 322 and 324, is very much larger than in any others. A probable explanation of this is found in the following facts.

After planting, and before the plants appeared, it was noticed that birds sometimes perched on the edges of the pots, and their droppings were found in some cases on the soil surface within. These were removed as promptly and thoroughly as possible and close watch was kept during the day until the plants fully occupied the pots.

In the pots named, however, it is probable that droppings left on them during a shower, or when the surface soil was quite damp, were partly carried into the soil by moisture, before they were discovered and removed, thus adding materially to the available nitrogen within the soil.

Excluding the crops mentioned, the average quantity of nitrogen taken from the soil was 0.160 gram. The greatest range from this mean was 0.040 below and 0.046 above. In twenty-four crops the nitrogen was within 10 per cent. of the mean.

It would not be possible to determine any very fine differences between the availability of different forms of nitrogen, in experiments where the crop-nitrogen in duplicate tests varies as much as was here observed. But the agreement is close enough to admit of determining any considerable differences, and it may be assumed that—with the exceptions above noted—*after the oat crops were harvested*, the amounts of available nitrogen in all the pots were quite small and fairly uniform.

Maize Cultures. Availability of Bone-nitrogen.

Immediately after the oats were harvested, additional fertilizers were mixed with the soil in the way already described, and maize was planted.

From a sample of ground raw knuckle bone, such as is used for the manufacture of case-knife handles, five grades of bone were prepared.

Description of Grades of Bone used in the Experiment.

Grade
A, passes bolting cloth, holes $\frac{1}{150}$ in. diameter,* contains 3.38 p. ct. nitrogen.
B, " circular holes between $\frac{1}{50}$ and $\frac{1}{150}$ in. diameter " 3.90 " "
C, " " " " $\frac{1}{25}$ " $\frac{1}{50}$ " " 4.07 " "
D, " " " " $\frac{1}{12}$ " $\frac{1}{25}$ " " 4.05 " "
E, " " " " $\frac{1}{8}$ " $\frac{1}{12}$ " " 4.08 " "

* The mesh is 0.16^{mm} wide in the clear. The holes are not circular but rather octagonal in outline.

To the soil of each pot were added 16 grams of cotton hull ashes, containing 26.31 per cent. of potash and 10.47 per cent. of phosphoric acid, with the quantities of nitrate, bone or cotton seed meal given in Table VII, page 202.

Maize was planted on July 16th, 4 kernels in each pot, and was harvested late in September. At harvest time plants in all the pots bore staminate, some also pistillate flowers, but no ears had formed.

The arrangement of the experiment and the results are shown in Table VII.

In order to ascertain whether in all cases there had been surplus phosphoric acid and potash in the soil, these were determined in both the oat and maize crops from pots 288 and 314. From the data already given the quantities of soluble potash and phosphoric acid added to the soil in the fertilizers, exclusive of that contained in the nitrogenous manures, is readily determined. The results are as follows:—

PHOSPHORIC ACID AND POTASH IN FERTILIZERS AND CROPS.

	Oats.		Maize.		
	Added in fertilizer.	Removed in crop.	Added in fertilizer.	Removed in crop.	Left in soil from fertilizer.
Pot No. 288.					
Phosphoric Acid	.928	.104	1.675	.308	2.191
Potash.............	2.369	.468	4.210	2.702	3.409
Pot No. 314.					
Phosphoric Acid	.928	.165	1.675	.416	2.032
Potash.............	2.369	.547	4.210	2.500	3.532

As these crops are among the largest, it is clear that both phosphoric acid and potash were present in excess of crop requirements.

Soil-Nitrogen.

The first six maize crops (Table VII) were intended to grow without any fertilizer-nitrogen. The crop No. 324 and the corresponding oat crop were very large, probably because of accidental bird droppings whose nitrogen was not wholly exhausted by the oat crop.

Excluding No. 324, it appears that the maize crop was able to get from the soil alone on the average 0.267 gram of nitrogen (the extremes are 0.221 and 0.287) and to produce 41.4 grams of dry matter (40.5–51.2).

TABLE VII. AVAILABILITY OF BONE-NITROGEN. MAIZE CULTURES.

No.	Nitrogen supplied— In form of—	Nitrogen supplied— Quantity of, in grams.	Crop Statistics. Average height of stalks. Inches.	Weights of air-dry Crops (grams).	Weights of Water-free Crops (grams).	Percentages of Nitrogen in air-dry Crops	Total Nitrogen of Crops (grams).	Nitrogen Increase.	Percentage Availability of Nitrogen.	Average Availability.	Corrected Averages
277	None added......	--	18	40.0	37.6	.62	.248	....	....		
285	"	--	14	37.3	35.4	.71	.265	....	....		
301	"	--	15	42.5	40.0	.52	.221	....	....		
313	"	--	19	48.6	45.5	.65	.316	....	....		
324	"	--	19	67.2	62.7	.51	[.343]	....	...		
278	"	--	24	51.2	48.3	.56	.287	....	....		
290	Nitrate of Soda...	1.0	36	143.5	134.1	.56	.804	.537	53.7		
287	" " ...	1.0	40	151.1	142.0	.61	.922	.655	65.5		
314	" " ...	2.0	40	208.4	196.6	.72	1.500	1.233	[61.7]		
312	" " ...	2.0	48	196.8	185.7	.70	1.378	1.111	55.6	57.7	57.2
323	" " ...	3.0	42	176.7	167.3	1.09	1.926	1.659	55.3		
300	" " ...	3.0	46	173.5	163.9	1.12	1.943	1.676	55 9		
279	Cotton Seed Meal.	1.0	32	120.8	113.4	.47	.568	.301	30.1		
291	" " " .	1.0	23	90.3	83.9	.53	.479	.212	21.2		
303	" " " .	2.0	38	153.0	146.0	.54	.826	.559	28.0		
286	" " " .	2.0	46	193.4	183.8	.46	.890	.623	31.2	28.4	28.9
322	" " " .	3.0	29	124.2	117.2	.84	1.043	.776	[25.9]		
288	" " " .	3.0	52	237.0	223.8	.54	1.280	1.013	33.8		
280	Bone A	1.0	18	66.7	62 9	.50	.334	.067	6.7		
317	"	1.0	17	51.3	48.0	.52	.267	....	....		
304	"	2.0	23	90.8	84.9	.54	.490	.223	[11.2]		
310	"	2.0	23	77.5	72.4	.54	.419	.152	7.6	10.0	9.7
321	"	3.0	45	143.5	135.5	.66	.947	.680	22.7		
306	"	3.0	28	100.2	94.9	.61	.611	.344	11.5		
281	Bone B	1.0	22	52.1	48.9	.54	.281	.014	1.4		
293	"	1.0	15	36.7	34.4	.66	.242	.075	7 5		
299	"	2.0	16	53.0	49.9	.60	.318	.051	2.6		
309	"	2.0	18	66.0	61.8	.50	.330	.063	3.2	3.4	3.0
320	"	3.0	21	75.4	70.6	.57	.430	.163	[5.4]		
283	"	3.0	20	47.1	43.9	.58	.273	.006	.2		
282	Bone C	1.0	19	50.3	47.2	.54	.272	.005	.5		
294	"	1.0	18	42.1	39.6	.56	.236	....	....		
297	"	2.0	28	79.2	73.9	.57	.451	.184	9.2		
308	"	2.0	24	57.0	52.9	.58	.331	.064	3.2	4.2	4.2
319	"	3.0	25	81.5	77.8	.56	.456	.189	6.3		
295	"	3.0	24	67.5	63.1	.66	.446	.179	6.0		
284	Bone D	1.0	16	33.2	31.0	.63	.209	....	....		
302	"	1.0	22	50.1	47.1	.64	.321	.054	5.4		
296	"	2.0	24	58.0	54.5	.58	.336	.069	3.5		
307	"	2.0	19	52.8	49.5	.52	.275	.008	.4	2.3	1.9
318	"	3.0	25	76.2	72 8	.52	.396	.129	[4.3]		
292	"	3.0	17	46.2	43.3	.59	.273	.006	.2		
289	Bone E	1.0	17	39.3	36.4	.56	.220	....	....		
311	"	1.0	23	56.1	52.2	.60	.337	.070	7.0		
306	"	2.0	21	52.3	48.8	.53	.277	.010	.5		
315	"	2.0	25	69.3	64.6	.60	.416	.149	7.5	2.7	2.7
316	"	3.0	16	54.2	50.5	.52	.282	.015	.5		
298	"	3.0	16	50.0	47.2	.56	.280	.013	.4		

Nitrate-Nitrogen.

The next six crops received fertilizer-nitrogen in form of nitrate of soda, and in three different amounts.

The weights of crop and crop-nitrogen were excessive in No. 314; the nitrogen-yield in the corresponding oat crop was also very large. This crop is therefore omitted from the average.

In the column of "Nitrogen Increase" are given figures obtained by subtracting from the total crop-nitrogen, the average quantity of nitrogen (0.267 gram) which the unfertilized soil itself yielded, as determined by the first six crops given in Table VII.

The nitrogen-increase is what may fairly be attributed to the nitrogen of the fertilizer rather than to that of the soil and seed.

The column "Per cent. availability" expresses the percentage of the fertilizer-nitrogen which was recovered in the crop.

Next follows the average of the six separate tests, and from the last column, "Corrected Averages," are excluded crops (like 314), which were affected by some known source of error.

It appears that the average availability of the nitrogen of nitrate of soda was 57.2 per cent. (53.7–65.5). That is, of every one hundred parts applied in the fertilizer, 57.2 parts were taken by the crop. It is quite clear too that the amount of nitrogen added was not in excess of the crop requirements.

Nitrogen of Cotton Seed Meal.

Of the maize crops raised with cotton seed meal, one, No. 322, followed a very large oat crop, but was much smaller than its duplicate. Whether it is excluded from the "corrected average" or not, makes practically no difference in the result, for the "average availability" is 28.4 and the "corrected average" 28.9.

In these experiments the nitrogen-availability of cotton seed meal was about half that of nitrate of soda.

The figures given on page 190 show that the average availability of nitrogen in form of cotton seed meal in three years' experiments in coal ashes and peat, has been nearly three-quarters (74 per cent.) of that of nitrate-nitrogen.

A word as to the discrepancy between these results. The conditions which affect that decay of organic nitrogenous matters in the soil, which necessarily precedes the taking up of their nitrogen by plants (chief among which are aeration of the soil,

moisture, warmth and the activity of microbe life in the soil), are not and cannot be made alike year after year. In one year they may all be very favorable, in which case the nitrogen of cotton seed meal, for example, will have a higher availability as compared with that of nitrate; in the next year the reverse may be true. Thus in 1894 the per cent. availability of nitrogen of the same cotton seed meal was 87, in 1895, 72, in 1896, 62 per cent. of that of nitrate-nitrogen.

Nitrogen of Bone.

The tests made with the finest bone, grade A, show great irregularities, which cannot be explained. Crop No. 304 followed an oat crop whose nitrogen content was excessively large. The yield of nitrogen in the maize crop is, however, about the average of the others, so that whether this result is excluded from the corrected average or not, makes no difference in the result.

The percentages representing availability of nitrogen in four of the crops are 6.7, 7.6, 11.2, and 11.5. But in another crop we have a relative availability of 22.7, and in another no more nitrogen was taken by the crop than belonged to crops which received no fertilizer-nitrogen whatever. The tests with coarser grades of bone show less wide range of results. The figures obtained are as follows:

PER CENT. AVAILABILITY OF BONE NITROGEN.

			Average per cent. availability of nitrogen.	Range of results.
Grade	A.	Passed fine bolting cloth....	9.7	22.7—0
"	B.	Smaller than $\frac{1}{50}$ inch.......	3.0	7.5—.2
"	C.	$\frac{1}{50}$ to $\frac{1}{25}$ inch	4.2	9.2—0
"	D.	$\frac{1}{25}$ to $\frac{1}{12}$ "	1.9	5.4—0
"	E.	$\frac{1}{12}$ to $\frac{1}{6}$ "	2.7	7.5—0

These experiments of a single year have shown that, under the conditions specified, fine bone flour prepared from the hardest bones (selected raw knuckle bones free from all tendon, cartilage, etc.), was about one-third as efficient a source of nitrogen to the maize crop as cotton seed meal, and that the coarser grades of bone supplied but very little nitrogen to the growing crop.

When the crops which have been described were harvested, the pots were planted with winter rye. The experiments must be continued for several years in order to arrive at safe conclusions.

ON THE USE OF COMMERCIAL FERTILIZERS FOR FORCING-HOUSE CROPS.

BY E. H. JENKINS AND W. E. BRITTON.*

I. EXPERIMENTS WITH TOMATOES, SEASON OF 1895–1896.

This work is a continuation of that begun two years since and described in the Report of this Station for 1895, pp. 75 to 98.

The experiments now to be described were planned to test further the use of a mixture of coal ashes with a few per cent. of peat for forcing crops, to determine more closely the amount of nitric nitrogen which can be economically used in such a soil for growing tomatoes, and to study the effects of larger quantities of phosphoric acid than we had previously employed.

House, Benches and Plots.

The house and the arrangement of benches in it were the same as described on pp. 77 and 78 of the Report for 1895. The bench space in the house was divided by board partitions into 30 plots. These were nearly alike in shape and had the same depth (9 inches) and the same area (13.87 square feet).

Soil and Fertilizers.

Two kinds of soil were employed. One was a compost, such as is commonly used in forcing-houses, consisting of thick turf composted with one-third its bulk of stable manure and well worked over during the preceding summer.

The other soil, for each plot, consisted of 300 pounds of coal ashes mixed with 100 grams of pure calcium carbonate, nine pounds of moss peat, such as is sold in the cities for stable bedding, or with a like amount of meadow peat from a swamp near New Haven. Both ashes and peat were sifted through a wire screen having four meshes to the linear inch.†

The fertilizer chemicals designed for a plot were sprinkled on

* The general plan of this study, the arrangement of its details and the preparation of this paper are our joint labor. The horticultural work has been done wholly by Mr. Britton. The chemical analyses have been made by Messrs. Winton, Ogden and Mitchell.

† Note by S. W. JOHNSON—Our use of Peat as an ingredient of the "soil" employed for experimental cultures, is the result of my experience in an investigation "On the Effect of Alkaline Bodies in developing the Fertilizing Power of

the mixture of ashes and peat, and the whole was carefully and repeatedly shovelled over to secure perfect mixture.

The soil filled each plot to a depth of about eight inches. The kinds and quantities of fertilizers applied will be seen from subsequent tables.

The First Crop.

Plants.—Seeds of the Lorillard tomato were sown July 25th, potted August 20th into 2½ inch pots and shifted into 4 inch pots about the middle of September. Six of these plants, with the potting earth about them, were set in each of the forcing-house plots on Sept. 27th and 28th. The plants were trained to a single stem. All lateral shoots were pinched off as they appeared, dried and carefully saved for analysis, those from each plot separately.

Notes Regarding Growth.—During the period of growth, and ripening of the fruit, cloudy weather prevailed and the small yield was doubtless due to the lack of sunlight.

The plants, however, grew well from the beginning. Flowers were pollinated every second day throughout the fruiting season,

Peat," made in 1862 (briefly described in the writer's "Peat and its Uses as Fertilizer and Fuel," pp. 77–81; also in Storer's Agriculture, Vol. II, p. 19), in which it was found that maize plants rooted in peat, withstood great heat and occasional drouth without apparent injury.

A mixture of Coal Ashes and Peat was first used in our Vegetation Cultures, for studying the Availability of Nitrogen in Fertilizers, Report for 1893, p. 231. The coal ashes were either those of anthracite coal taken directly from the furnace of the large boiler that supplies steam heat to the Station buildings, or those of bituminous coal from the Whitney Lake Pumping House. These ashes contain some partially burned coal and considerable slag as well as pulverulent ash and clay.

The Peat was either a dark brown meadow "muck" from the Beaver Swamp meadow near New Haven, formed from grasses, sedges, etc., and rich in slowly available nitrogen, or the imported brown moss peat (Commercial Peat Moss) used as stable litter. The former is the cheaper and more convenient to pulverize. This Mixture is easily prepared in large quantities, is almost entirely sterile both as regards plant food and living organisms of all kinds; its texture and physical characters are more favorable to vegetation than those of quartz sand, usually employed, since it largely consists of mineral grains of very various dimensions intimately mixed together, and contains a small proportion of highly porous humus.

Its cheapness and the excellent results obtained with it, when duly enriched with plant food, have led us to employ it as a substitute for the usual compost. It is free, not only from insects and worms, but probably also from the denitrifying organisms so abundant in dung, and perhaps in composts, which dissipate the nitrogen of nitrates.

beginning on October 19th. For this purpose a spoon is held directly under each flower and the upper part of the blossom gently tapped with a pencil or small stick. Pollen is thus shaken into the spoon and at the same time the stigma is coated with it, and as flower after flower is visited on many different plants, cross-fertilization is insured.

About the middle of October a fungus (*Cladosporium fulvum*), appeared as yellowish-brown patches on the under side of the leaves of a few plants, but was quickly checked and soon eradicated by treatment with ammoniacal copper carbonate.

On November 9th, there appeared on the leaves of a few plants the injury known as "blight," "sunscald" or "burn," which very seriously damaged some of the crops and in consequence impaired the value of the experiment. A description of this trouble is given on subsequent pages.

The surface soil of all the plots was stirred every few days to check evaporation. The plants were watered whenever it was thought necessary and the atmosphere was kept moist by wetting the walks daily between nine and ten o'clock in the morning. On sunny days the wetting was repeated in the afternoon to keep the temperature from running too high.

The temperature was maintained between 65° and 70° Fahr. at night and about 10° higher during the day.

Harvesting.—Every plant was numbered and each tomato when picked was weighed and credited to the plant which bore it. It was therefore possible to judge whether the several plants in each plot were of fairly uniform vigor and bearing capacity. The first ripe fruits were harvested November 27th from plot 35 (compost), and the next were picked December 2d from plots 12, 28 and 32 (coal ashes, etc.), and from plot 20 (compost). The yield of each plot, given in Tables I and II, pages 210, 211, will be discussed later. The experiment was concluded on January 21st, 1896.

The plants, including roots, so far as it was easily practicable to gather them, and immature fruit from each plot were dried, added to the dried trimmings of the plants saved during the growing season and the whole was weighed and analyzed to determine the content of nitrogen, phosphoric acid and potash.

Average samples of fruit from both the coal ashes and the compost were analyzed and from its composition and total weight were calculated the quantities of nitrogen, phosphoric acid and potash removed by the fruit.

The Second Crop.

Immediately after the first crop was harvested and analyzed additional fertilizers were applied to some of the plots and tomato plants were set as before on all the plots.

Seed for these plants—a portion of the same stock from which the plants in the previous experiment came—was sown on December 14th; the seedlings were put in two-inch pots on December 26th and repotted to four-inch pots on January 22d.

The plants, which had been kept in a cool house and were stocky and in excellent condition, were finally set in the plots on February 14th.

Notes on the Growth.—The plants started into thrifty growth as soon as transplanted to the benches, and, by March 16th, were about two and one-half feet high. Flowers of the third clusters were then opening and most of the second clusters had set fruit. Soon after, the plants on plots 9, 10, 11 and 12 were somewhat affected by "scald;" some blossoms fell before opening and others failed to set fruit.

The first blossom appeared February 20th, and the blossoms were pollinated every day or two thereafter. The first ripe fruit was harvested April 21st from the coal ashes, plots 11, 25 and 29, and from the compost, plot 23.

The temperature, care and management of the house were essentially the same as for the first crop.

About May 1st many green tomatoes began rotting at the blossom end, being attacked by the common fungus (*Macrosporium tomato*), and ripened prematurely. The fungus was found on tomatoes grown in both coal ashes and compost, but was less prevalent on the south bench, where the flowers and fruits were nearer the glass and perhaps more fully exposed to the sun. From this time on no bottom heat could be given the plants through the night. It is quite probable that this change of condition, which noticeably checked the growth, favored the development of the fungus just referred to.

The yield, though larger than that of the first crop, on account of the increased amount of sunlight, was unquestionably lessened somewhat in every plot by the ravages of the *Macrosporium*.

The plants stood in the plots till July 8th, when they were harvested. The harvesting and subsequent work were the same as described for the first crop.

Discussion of Results.

A. The Nitrogen and Potash Series. Plots 9–14,* *Anthracite Coal Ashes and Moss Peat.*

The experiments of last year (see Report of 1895, p. 82) indicated that on plots of the size above named, 32.7 grams of nitrogen, with 8.1 grams of phosphoric acid and 29.3 grams of potash, gave a larger yield than smaller quantities of nitrogen with these amounts of phosphoric acid and potash.

We have now to inquire whether more nitrogen in the fertilizer increases the yield of the crop and whether a larger supply of phosphoric acid and potash may not render the nitrogen more effective.

As regards the question of Nitrogen Supply, Tables I, II, III and IV show the plan of experiments and their results.

The First Crop.

The largest amounts of nitrogen (32.7 grams), phosphoric acid (8.1 grams) and potash (29·3 grams), used last year, were employed this year for plot 9. While the quantities of potash and phosphoric acid in 10, 11 and 12 are alike (10 and 35 grams), the quantities of nitrogen are respectively 32.7, 40 and 47 grams.

Plot 13 had the same quantities of nitrogen and phosphoric acid as plot 11, but a larger amount of potash, to determine whether the nitrogen in plot 11 was limited in crop production, by lack of potash. Plots 14 and 12 had equal quantities of nitrogen and phosphoric acid, but the former had more potash than the latter.

* The situation of these plots in the forcing-house is shown in plate I, page 231.

14

TABLE I.—TOMATO CULTURES IN ANTHRACITE COAL ASHES AND MOSS PEAT, SEPT. 1895 TO FEB. 1896.

NITROGEN AND POTASH SERIES.

Fertilizers.	Plot 9	Plot 10	Plot 11	Plot 12	Plot 13	Plot 14
Nitrate of Soda, grams	204.2	204.2	249.6	295.0	249.6	295.0
Nitrogen, "	32.7	32.7	40.0	47.0	40.0	47.0
Dissolved Bone Black "	47.9	58.8	58.8	58.8	58.8	58.8
Phosphoric Acid, "	8.1	10.0	10.0	10.0	10.0	10.0
Muriate of Potash, "	58.6	70.0	70.0	70.0	80.0	90.0
Potash, "	29.3	35.0	35.0	35.0	40.0	45.0
Yield.						
Total yield of fruits, grams*	2987	3847	4425	5274	7548	8042
" " vines, "	265	281	286	312	359	383
" " roots, "	6.1	9.7	8.1	10.3	24.1	23.6
Average yield of fruits per plant, grams	498	641	738	880	1258	1340
" " " " pounds	1.1	1.4	1.6	1.9	2.7	3.0
Average number of fruits per plant	9.7	13.1	12.6	16.3	18.0	18.0
Average weight of ripe fruits, grams	57.4	55.6	70.8	64.7	84.5	84.2
Percent. of perfect shaped fruits	27.0	33.0	33.0	25.0	28.0	30.0
Average yield of fruits per square foot of bench area, grams	215	277	319	380	544	580
Average yield of fruits per square foot of bench area, pounds	.5	.6	.7	.8	1.2	1.3

The value of this experiment, so far as the first crop is concerned, was greatly impaired by the "burn" or "scald" already alluded to; nevertheless, it appears likely from inspection of Table I, that nitrogen was relatively deficient, on the first two plots, 9 and 10, at least. The increased yield of plot 14 over 13 may be due to the larger supply either of nitrogen or of potash.

Table III shows that from 37 to 48 per cent. of the nitrogen, from 55 to 73 per cent. of the phosphoric acid and from 59 to 84 per cent. of the potash contained in the fertilizer and ashes, were taken up by the first crop.

The Second Crop.

Before planting the second crop, nitrate of soda, dissolved bone black and muriate of potash were added to the plots of this series in such quantities as to exactly replace the nitrogen, phosphoric acid and potash removed by the first crop, including roots.

* Small unripe tomatoes remaining on the vines at time of harvest were weighed and recorded with the other fruits. The total and average yield and number of fruits per plant include these, but in computing the average weight of fruits, the number and weight of ripe fruits only were taken.

TABLE II.—TOMATO CULTURES IN ANTHRACITE COAL ASHES AND MOSS PEAT, FEBRUARY TO JULY, 1896.

NITROGEN AND POTASH SERIES.

Fertilizers.	Plot 9	Plot 10	Plot 11*	Plot 12†	Plot 13	Plot 14
Nitrate of Soda, grams	204.2	204.2	249.6	....	249.6	295.1
Cotton Seed Meal, "	....	....	....	§205.8	....	....
Nitrogen, "	32.7	32.7	40.0	47.0	40.0	47.0
Dissolved Bone Black, "	47.9	58.8	58.8	58.8	58.8	58.8
Phosphoric Acid, "	8.1	10.0	10.0	10.0	10.0	10.0
Muriate of Potash, "	58.6	70.0	70.0	70.0	80.0	90.0
Potash, "	29.3	35.0	35.0	35.0	40.0	45.0
Carbonate of Magnesia, "	24.0	....	....	....	....	....
Carbonate of Lime, "	100.0	....	....	....	....	....

Yield.

Total yield of fruits, grams‡	7987	7682	10385	9507	10427	11467
" " vines, " / " " roots, "	477	537	532	582	637	721
Average yield of fruits per plant, grams	1331	1280	1731	1584	1738	1911
" " " " pounds	2.9	2.8	3.8	3.5	3.8	4.2
Average number of fruits per plant	10	10	18	16	15	19
Average weight of ripe fruits, grams	138	125	120	118	124	116
Percent of perfect shaped fruits	12	35	19	28	52	49
Average yield of fruits per square foot of bench area, grams	576	554	749	686	752	827
Average yield of fruits per square foot of bench area, pounds	1.3	1.2	1.7	1.5	1.7	1.8

Turning now to Table II, giving the results of the second experiment, it is to be noted that the plants on plots 13 and 14 were healthy throughout the season, those on plot 12 were slightly affected with scald, those on 9, 10 and 11 were considerably injured, and that to 9, 11 and 12 some applications were made which render the results on those plots not strictly comparable with the others.

The much larger yield from each plot in the second experiment, Table II, in which the amount of plant food used was the same as in the first experiment, stands connected with the greater supply of sunshine.

* Also added 18 lbs. moss peat.
† Also added a handful of garden soil.
‡ See note to Table I.
§ This amount of cotton seed replaces the nitrogen removed in the first crop.

TABLES III AND IV.—TOMATO CULTURES IN ANTHRACITE COAL ASHES AND MOSS PEAT.

TABLE III.—SUPPLY AND REMOVAL OF FERTILIZER ELEMENTS IN FIRST CROPS, SEPT., 1895, TO FEB., 1896.

	Plot 9	Plot 10	Plot 11	Plot 12	Plot 13	Plot 14
Nitrogen in fertilizer, grams	32.7	32.7	40	47	40	47
Nitrogen in crop, grams	12.68	13.88	14.92	17.26	19.15	21.65
Nitrogen taken by crop,* percent.	39	42	37	37	48	46
Phos. acid in fertilizer, grs.	8.1	10.0	10.0	10.0	10.0	10.0
Phos. acid in crop, grams	5.09	5.53	6.14	6.31	6.85	7.29
Phos. acid taken by crop,* percent.	63	55	61	63	69	73
Potash in fertilizer, grams	29.3	35.0	35.0	35.0	40.0	45.0
Potash in crop, grams	18.74	20.97	22.54	25.54	33.47	36.51
Potash taken by crop*, percent.	64	59	65	73	84	81

TABLE IV.—SUPPLY AND REMOVAL OF FERTILIZER ELEMENTS IN SECOND CROPS, FEB. TO JULY, 1896.

	Plot 9	Plot 10	Plot 11	Plot 12	Plot 13	Plot 14
Nitrogen in fertilizer, grams	32.7	32.7	40.0	47.0	40.0	47.0
Nitrogen in crop, grams	17.65	17.66	22.26	20.33	22.54	26.06
Nitrogen taken by crop,* percent.	54	54	56	43	56	55
Phos. acid in fertilizer, grs.	8.1	10.0	10.0	10.0	10.0	10.0
Phos. acid in crop, grams	6 53	6.71	9.41	7.52	7.74	7.81
Phos. acid taken by crop,* percent.	81	67	94	75	77	78
Potash in fertilizer, grams	29.3	35.0	35.0	35.0	40.0	45.0
Potash in crop, grams	35.09	35.65	42.79	38.80	42.02	46.66
Potash taken by crop,* percent.	119	102	122	111	105	104

Table IV shows that from 43 to 56 per cent. of the nitrogen, from 75 to 94 of the phosphoric acid and from 102 to 122 per cent. of the potash in the fertilizer, were taken up by the crop.

It appears probable that in every case the nitrogen was limited in its efficiency by scarcity of potash if not of phosphoric acid.

The results also show that the crop took some potash from the ashes used as soil.

On plots 13 and 14, about 72 per cent. of the nitrogen, 91 per

* i. e., parts harvested per 100 applied.

cent. of the phosphoric acid and 72 per cent. of the potash taken from the soil in the second crop, were found in the fruit. In round numbers, therefore, more than three-fourths of the plant food taken passed into the fruit; last year four-fifths was in the fruit.

The ratio of phosphoric acid to nitrogen and potash in the total crops on plots 13 and 14 is 1: 3.0: 5.3. The corresponding ratios in the fertilizers applied to these two plots are, on plot 13, 1: 4.0: 4.0 and on plot 14, 1 : 4.7 : 4.5.

It may be here remarked that the ratio of these ingredients to each other in the total crop is no sure indication of the ratio which they should bear to each other in the fertilizer.

Potash supplied by the Soil.

In two cultures carried out by way of control to ascertain to what extent potash existed in the anthracite coal ashes in available form, plot 17A received 40 grams of nitrogen and 10 grams of phosphoric acid with no potash. The yield of fruit and the quantities of fertilizer ingredients taken by the crops were:

Yield of Plot 17 A.

	First Crop.	Second Crop.	Total.
Weight of fruit,......pounds	12.00	9.10	21.10
" " ......grams	5436.00	4150.00	9586.00
Nitrogen in Crop, ... "	14.64	12.48	27.12
Phosphoric acid in Crop, "	4.38	3.00	7.38
Potash in Crop,....... "	20.24	19.76	40.00

The two crops were able to obtain 40 grams of potash from the coal ashes, about three-fifths as much as was taken in the two crops from plot 13, to which like amounts of nitrogen and of phosphoric acid, together with 80 grams of potash, had been added in the fertilizer.

B. The Phosphoric Acid Series, Plots 27–32, Bituminous Coal Ashes and Meadow Peat.*

The plan of experiments bearing on the phosphoric acid supply and the results are shown in Tables V, VI, VII and VIII. In this series bituminous coal ashes and peat obtained from Beaver Meadow Swamp near New Haven, were used. Moss peat contains but 0.6 per cent. of nitrogen and this is quite unavailable to the tomato plant, as was proved by our experiments last year

* See Plate I, page 231.

(Report 1895, p. 84), but the Beaver Meadow peat contains over two per cent. of nitrogen whose availability to the tomato plant we have not yet determined.

First Crop.

The six plots, 27 to 32 inclusive, were each fertilized with 40 grams of nitric nitrogen and 35 grams of potash. To plot 27 no phosphoric acid was added, but plots 28, 29, 30, 31 and 32 received 4, 8, 10, 12 and 15 grams of phosphoric acid respectively.

All the plants in plots 27 to 32 were free from disease and developed normally, except one in plot 29 which was injured and rejected.

The figures representing the yield of plot 29 have accordingly been increased by one-fifth to make them more nearly comparable with the others.

The statistics of the first crop, Tables V and VII, show that:

TABLE V.—TOMATO CULTURES IN BITUMINOUS COAL ASHES AND MEADOW PEAT. SEPT., 1895, TO FEB., 1896.

PHOSPHORIC ACID SERIES.

Fertilizers.	Plot 27	Plot 28	Plot 29†	Plot 30	Plot 31	Plot 32
Nitrate of Soda, grams	249.6	249.6	249.6	249.6	249.6	249.6
Nitrogen "	40.0	40 0	40.0	40.0	40.0	40.0
Dissolved Bone Black, "	none	23.5	47.1	58.8	70.5	88.3
Phosphoric Acid, "	"	4.0	8.0	10.0	12.0	15.0
Muriate of Potash, "	70.0	70.0	70.0	70.0	70.0	70.0
Potash, "	35.0	35.0	35.0	35.0	35.0	35.0
Yield.						
Total yield of fruits, grams*	4269	5140	4804	5795	6599	7214
" " vines, "	288	304	327	296	366	365
" " roots, "	20.7	23.8	24.0	17.5	21.0	22.5
Average yield of fruits per plant, grams	712	857	801	966	1099	1202
" " " " pounds	1.6	1.9	1.8	2.1	2.4	2.6
" number of fruits per plant	10	12	14	13	17	18
" weight of ripe fruits, grams	79	87	65	79	70	78
Percent of perfect-shaped fruits	42	37	46	35	55	60
Average yield of fruits per square foot of bench area, grams	308	370	347	418	476	520
Average yield of fruits per square foot of bench area, pounds	.7	.8	.8	.9	1.1	1.2

* See note to Table I, page 210.

† One plant rejected. Stated yield is one-fifth greater than actual yield.

1. With 40 grams of nitrogen and 35 of potash the application of 15 grams of phosphoric acid gave a larger yield of fruit and of total crop than any smaller application, and make it probable that larger quantities of phosphoric acid would have still further increased the yield.

2. The chemical analysis of the crop on plot 27, Table VII, shows that when no phosphate was added, the crop was able to gather from the coal ashes of which the soil was largely composed, 4.28 grams of phosphoric acid; more than half as much as was assimilated by the crop on plot 32. A similar experiment on plot 17B. from which two tomato crops were harvested is described on p. 216.

3. That the yield of fruit was not larger in plots 27 to 32 than on plots 13 and 14, may be due to the fact that the former were less favorably situated as regards light and air than the plots in the nitrogen series.

4. The fact that 86 to 90 per cent. of the fertilizer-potash on plots 31 and 32 were taken up by the crop, makes it probable that the efficiency of the nitrogen and phosphoric acid supplies on these plots was limited somewhat by the supply of potash.

5. On plots 31 and 32 about 54 per cent. of the nitrogen, 61 per cent. of the phosphoric acid and 65 per cent. of the potash taken up by the crop, or in round numbers, a little less than two-thirds of the whole, was contained in the fruit.

Second Crop.

In preparation for the second crop, fertilizers were applied to each plot in amount sufficient to replace the nitrogen, phosphoric acid and potash, which were removed by the first crop, and to increase these quantities up to 55 grams in the case of nitrogen, and 50 grams in that of potash.

The quantities of phosphoric acid in each plot after the second application were as follows:

Plot 27, 15 grams.	Plot 30, 24 grams.
Plot 28, 21 grams.	Plot 31, 27 grams.
Plot 29, 21 grams.	Plot 32, 30 grams.

The smallest quantity (15 grams) of phosphoric acid is the same as the largest amount used for the first crop, Table V, and the quantity was increased in successive plots to 30 grams.

The results given in Table VI and VIII indicate that:

TABLE VI.—TOMATO CULTURES IN BITUMINOUS COAL ASHES AND MEADOW PEAT. FEBRUARY TO JULY, 1896.

PHOSPHORIC ACID SERIES.

Fertilizers.	Plot 27	Plot 28	Plot 29†	Plot 30	Plot 31	Plot 32
Nitrogen in Nitrate of Soda, grams	55.0	55.0	55.0	55.0	55.0	55.0
Phosphoric Acid in Diss. Bone Black, "	15.0	21.0	21.0	24.0	27.0	30.0
Potash in Muriate of Potash, "	50 0	50.0	50.0	50.0	50.0	50.0

Yield.

Total yield of fruits, grams*	8902	9661	9405	10135	9337	8950
" " vines, " } " " roots, " }	686	452	659	808	556	520
Average yield of fruits per plant, grams	1483	1610	1567	1689	1556	1492
" " " " " pounds	3.3	3.5	3.4	3.7	3.4	3.3
" number of fruits per plant	14	16	14	18	16	14
" weight of ripe fruits, grams	113	112	117	97	102	108
Percent. of perfect-shaped fruits	67	63	42	60	64	63
Average yield of fruits per square foot of bench area, grams	642	697	678	731	673	646
Average yield of fruits per square foot of bench area, pounds	1.4	1.5	1.5	1.6	1.5	1.4

1. With 55 grams of nitrogen and 50 of potash in the fertilizer, 24 grams of phosphoric acid, plot 30 gave the largest yield, and larger amounts of phosphoric acid, plots 31 and 32, did not increase but rather depressed the yield.

2. The per cent. of fruit of perfect shape in plots 27 to 32 was much larger than in any other plots.

3. On plot 30, which gave the largest yield, rather more potash was taken by the crop than was added in the fertilizer. It is, therefore, possible that the yield was limited by the potash supply.

4. Fifty-two per cent. of the nitrogen, 65 per cent. of the phosphoric acid and 54 per cent. of the potash taken up by the crop were found in the fruit, on plot 30.

Phosphoric Acid supplied by the Soil.

Plot 17 B, not included in Tables V–VIII, was filled with anthracite ashes and peat from Beaver Meadow, to which were added 40 grams of nitric nitrogen and 35 grams of potash, but no phospho-

* See note at bottom of Table 1, p. 210.

† One plant rejected.

ric acid. The quantities of nitrogen and of potash removed in the first tomato crop were added to the soil in form of nitrate of soda and muriate of potash before the second crop was planted. The object of this experiment was to determine how much phosphoric acid the two tomato crops were able to obtain from the ashes and peat.

Tables VII and VIII.—Tomato Cultures in Bituminous Coal Ashes and Meadow Peat.

Table VII.—Supply and Removal of Fertilizer Elements in First Crops. September, 1895, to February, 1896.

	Plot 27	Plot 28	Plot 29	Plot 30	Plot 31	Plot 32
Nitrogen in fertilizer, grams	40.0	40.0	40.0	40.0	40.0	40.0
Nitrogen in crop, "	13.3	17.04	13.34	15.49	19.83	20.66
Nitrogen removed by crop,* percent.	33	43	33	39	49	52
Phos. acid in fertilizer, grams	0.0	4.0	8.0	10.0	12.0	15.0
Phos. acid in crop, "	4.28	5.10	4.29	5.81	7.05	7.59
Phos. acid removed by crop,* percent.	...	127.0	54	58	59	50
Potash in fertilizer, grams	35.0	35.0	35.0	35.0	35.0	35.0
Potash in crop, "	21.75	24.75	19.52	24.01	30.12	31.24
Potash removed by crop percent.	62	71	56	70	86	90

Table VIII.—Supply and Removal of Fertilizer Elements in Second Crops. February to July, 1896.

	Plot 27	Plot 28	Plot 29	Plot 30	Plot 31	Plot 32
Nitrogen in fertilizer, grams	55.0	55.0	55.0	55.0	55.0	55.0
Nitrogen in crop, "	24.94	24.14	24.18	31.33	24.28	25.14
Nitrogen removed by crop,* percent.	44	44	44	57	44	46
Phos. acid in fertilizer, grams	15	21	21	24	27	30
Phos. acid in crop, "	8.5	7.77	7.12	10.15	7.79	7.90
Phos. acid removed by crop,* percent.	53	37	34	42	29	26
Potash in fertilizer, grams	50	50	50	50	50	50
Potash in crop, "	43.04	39.0	36.95	54.19	42.48	43.12
Potash removed by crop, percent.	86	78	74	108	85	86

* i. e. parts harvested per 100 applied.

The weight of the fruit and the quantities of nitrogen, phosphoric acid and potash taken by the crops are as follows:—

YIELD OF PLOT 17 B.

		First Crop.	Second Crop.	Total.
Weight of fruits,	pounds	10.40	9.40	19.70
" "	grams	4708.00	4248.00	8956.00
Nitrogen in crop,	"	11.04	11.28	22.32
Phosphoric acid in crop,	"	2.58	2.36	4.94
Potash, "	"	21.12	16.78	37.90

These figures may be compared with those for the first crop from plot 32, which received the same quantities of nitrogen and potash and in addition 15 grams of phosphoric acid.

Plot 17 B produced, in the first crop, two-thirds as much fruit as plot 32, and took from the ashes alone 2.58 grams of phosphoric acid, one-third as much as was taken by the crop on plot 32.

The second crop on plot 17 B was somewhat smaller and took somewhat less phosphoric acid from the ashes (2.36 grams).

C. Comparison between Tomatoes raised in Compost and those raised in Coal Ashes and Peat.

Statistics regarding the yield on five plots filled with Compost are given in Table IX.

These plots were in different parts of the forcing house, somewhat differently exposed to light and heat. Plot 18 was thought to be the most favorably situated, and 23 ranked next. There was no appreciable difference in the relative exposures of the other plots.

Plots 18 and 23 received no chemical fertilizers, plot 37 received 35 grams of potash and 100 grams of carbonate of lime, while plots 19 and 22 each received in September, for the first crop, 32.7 grams of nitrogen, 10 of phosphoric acid and 29.3 of potash, and for the second crop, enough of each of these to replace the amount removed by the first crop.

The plants on these five plots were perfectly healthy through the season and kept their dark green color much longer than those grown in Coal Ashes and Peat.

Addition of fertilizer chemicals to this rich Compost soil, plots 19 and 22, did not increase the yield.

TABLE IX.—TOMATO CULTURES IN COMPOST, SECOND CROP. FEB. TO JULY, 1896.

Fertilizers.	Plot 18	Plot 23	Plot 37	Plot 19	Plot 22
Nitrogen in nitrate of Soda, grams	.....	.....	.....	32.7	32.7
Phosphoric acid in Diss. Bone Black, grams	.....	.....	.....	10	10
Potash in Muriate, grams	.....	.....	35	29.3	29.3
Carbonate of Lime, grams	.....	.....	100	.....	.....
Yield.					
Total yield of fruits, grams*	10558	8523	8984	9162	8820
Total yield of vines and roots, grams	898	608	919	1146	1001
Average yield of fruits per plant, grams	1759	1420	1497	1527	1470
Average yield of fruits per plant, pounds	3.9	3.1	3.3	3.4	3.2
Average number of fruits per plant	19	14	16	17	17
Average weight per fruits, grams	104	104	101	95	89
Percent. of perfect-shaped fruits	65	44	57	75	60
Average yield of fruits per square foot of bench area, grams	761	615	648	660	636
Average yield of fruits per square foot of bench area, pounds	1.7	1.4	1.4	1.5	1.4

Comparative Yield of Fruit.—In the following table are given the average weights of fruit and of nitrogen, phosphoric acid and potash in the total crops, from the five plots of Compost just described and, for comparison, the corresponding data for the three plots of Coal Ashes and Peat, in both the nitrogen series and phosphoric acid series which had received the largest applications of fertilizer chemicals.

	Average yield of fruit. (Grams.)	Quantities taken up by the Crops (grams). Nitrogen.	Phos. Acid.	Potash.	Ratios of Phos. Acid to Nitrogen and Potash.
Compost, plots 18, 23, 37, 19, 22	9209	27.3	10.5	54.9	1: 2.6: 5.2
Ashes and Peat, plots 30, 31, 32	9474	26.9	8.6	46.6	1: 3.1: 5.4
Ashes and Peat, plots 12, 13, 14	10467	23.0	7.7	42.5	1: 3.0: 5.5

The small differences in the yield of fruit are in favor of the Coal Ashes and Peat.

Time of Ripening.—The rate ot ripening is shown in Table X.

* See note, bottom of page 210.

TABLE X.—QUANTITIES OF TOMATOES HARVESTED IN SUCCESSIVE WEEKS FROM EQUAL AREAS OF COMPOST AND OF COAL ASHES AND PEAT.

	Compost.		Coal Ashes and Peat.	
Week ending	For the week. grams.	Total. grams.	For the week. grams.	Total grams.
April 28	1095	1095	884	884
May 5	2052	3147	895	1779
12	1107	4254	2249	4028
19	6280	10534	12121	16149
26	4178	14712	4313	20462
June 2	3192	17904	2431	22893
9	1951	19855	2200	25093
16	1909	21764	1423	26516
June 16 to July 8	6321	28085	4726	31242
Average per plot	9362		10414	

During the first two weeks the average yield of fruit from the Compost was the larger, for the next three weeks the Ashes and Peat produced the most, and thereafter the yield per week from the Compost was generally larger than from Ashes and Peat, although, as has been already noted, the total yield for the season was largest on the latter.

In this experiment fully two-fifths of the crop on Ashes und Peat ripened in a single week, while on Compost soil but one-fifth of the crop ripened in that time. This is a point of importance in forcing tomatoes for market which will receive further attention.

Root Galls.—Two plots, 20 and 21, were used to study the development of root galls in soil which had carried tomatoes the previous year and had not been frozen or removed from the forcing-house.

Plot 21 was filled with Peat and Anthracite Ashes, to which were added 32.7 grams of nitric nitrogen, 8.1 grams of soluble phosphoric acid and 29.3 grams of potash. Plot 20 contained the Compost with the same addition of chemicals.

The roots of the crop in plot 20 were well covered with nematode galls, while in plot 21 there were no galls on the roots, outside of the ball of earth which was set in with the young plant.

The results of this season's work may be summarized as follows:

1. A crop of tomatoes, started in September and beginning to bear in December, was only seven-tenths as large as one started three months later, when the amount of sunlight was daily increasing.

2. The largest quantities of nitrogen, phosphoric acid and potash taken by any one crop, [Plot 30, Feb. to July, 1896,] per 100 square feet of bench space, were as follows:

	Grams.		Pounds.	Ounces.	
Nitrogen.........	226	Equivalent to	3	10	Nitrate of Soda.
Phosphoric Acid.	74	"	1		Dissolved Bone Black.
Potash...........	391	"	1	12	Muriate of Potash.

The crop on this plot amounted to 1.6 pounds of tomatoes per square foot of bench space, but other crops of 1.8 pounds took no larger quantities of fertilizer ingredients from the soil.

3. Somewhat less than two-thirds of these fertilizer ingredients were contained in the fruit.

4. To enable the plants to get these fertilizer elements as required, there should be a large excess of them in the soil.

5. With the larger amounts of fertilizer chemicals used on the plots this year, larger quantities of nitrogen, phosphoric acid and potash have gone into the fruit. Every 100 pounds of ripe tomatoes has taken :

	Ounces.		Ounces.	
Nitrogen.........	2.9	Equivalent to	18.2	Nitrate of Soda.
Phosphoric Acid.	1.2	"	7.5	Dissolved Bone Black.
Potash...........	5.0	"	10.0	Muriate of Potash.

6. By the use of fertilizer chemicals, and a soil consisting of Anthracite Coal Ashes mixed with a little Peat (3 per cent.) there has been no difficulty in raising a larger crop of tomatoes than was raised in a rich Compost either with or without fertilizer chemicals.

The quantities of fertilizer chemicals which gave the maximum yield in our experiments were, per 100 square feet of bench :

Nitrate of Soda.........	4 lbs.	11 oz.	costing	11.8	cents.
Dissolved Bone Black..		15 "	"	1.2	"
Muriate of Potash.....	1 "	2 "	"	2.4	"
Total.....................				15.4	

In our tests the average yield from Coal Ashes and Peat was one-tenth larger than from the Compost.

7. The plants began to bear at about the same time on both soils.

During the first two weeks the yield of fruit from Compost was the larger, for the next three weeks the Ashes and Peat produced the most, and thereafter the yield per week from Compost was generally larger than from Ashes and Peat, although the total yield for the season was largest on the latter.

Two-fifths of the whole crop from the Coal Ashes and Peat was harvested within one week. Naturally this comparison is only applicable to the particular soils under experiment. That Composts may differ very greatly in their adaptability to the growth of particular crops is matter of common observation.

8. Roots growing in Coal Ashes and Peat have not been affected by nematode galls.

II. Experiments with Radishes.

The plots used in this experiment were in a row on the west bench (see H, plate I) in the new forcing-house which is described on page 231, each having an area of 14.53 square feet. Plots Nos. 67 to 71 inclusive were filled to a depth of five inches with a mixture of coal ashes, peat and carbonate of lime such as is described on page 205, to which fertilizer chemicals were added in varying amounts.

Plots 72, 73 and 74 were filled to the same depth with a compost which was made of garden surface soil mixed with one-third its bulk of stable manure and had been worked over several times during the previous summer.

First Crop.

The general plan of these experiments and the results obtained are to be seen in Table XI, p. 223.

The benches were filled on Jan. 11th and 13th, and on the 14th were sown with seed of Cardinal Globe radish from H. A. Dreer, Philadelphia, at intervals of two inches in rows 4½ inches apart, and were covered about ⅝ inch deep.

All the seed germinated. On Jan. 31, the seedlings had come up, and quite evenly, except on plot 74. The smallest plants were in plot 74, the largest in plots 72 and 73.

The temperature of the house was kept at about 65° F. during the day, and about ten degrees lower at night. The house was well ventilated, and the plants were syringed and watered as occasion required.

The radishes were pulled when ¾ inch in diameter, brushed clean and, after weighing, tied up, 10 in a bunch. The first were pulled on Feb. 15th, and all were gathered by the 24th.

Second Crop.

On Feb. 25th, all the plots were sown as before without any further addition of fertilizer chemicals. The plants came up within a few days.

On March 16, all were very even in size and color. The leaves seemed a trifle larger on No. 74 than on the other plots. This crop was harvested between March 24th and April 1st.

TABLE XI. RADISH CULTURES.

	ANTHRACITE COAL ASHES AND PEAT.					COMPOST.		
	Plot 67	Plot 68	Plot 69	Plot 70	Plot 71	Plot 72	Plot 73	Plot 74
First Crop. Fertilizers added.								
Nitrate of Soda, grams	162.9	203.4	242.9	203.4	203.4	....	....	162.9
Nitrogen. "	26.1	32.5	38.9	32.5	32.5	....	....	26.1
Dissolved Bone Black, "	80.0	80.0	80.0	80.0	80.0	....	....	80.0
Phosphoric Acid, "	13.2	13.2	13.2	13.2	13.2			13.2
Muriate of Potash, "	88.8	88.8	88.8	73.5	117.6	....	....	88.8
Potash, "	44.4	44.4	44.4	36.8	58.8	....	....	44.4
Number of bunches of radishes	25	22	22	20½	23	20½	23	24½
Weight of radishes, "	1703	1735	1568	1565	1599	1553	1558	1704
Second Crop. (No fertilizers added.)								
Number of bunches of radishes	25	25	24½	23½	23	17	16½	23
Weight of radishes, "	1534	1439	1442	1355	1374	795	651	1344
Third Crop. Fertilizers added.*								
Nitrate of Soda, "	47.4	46.5	44.1	42.8	43.5	....	....	41.5
Nitrogen, "	7.6	7.4	7.1	6.8	7.0	....	....	6.6
Dissolved Bone Black, "	50.4	50.2	49.6	49.6	49.5	....	120	53.1
Phosphoric Acid, "	8.2	8.1	8.0	8.0	8.0	....	19.8	8.6
Muriate of Potash, "	15.2	14.9	14.1	13.7	13.9	88.8	....	20.5
Potash, "	7.6	7.4	7.1	6.8	7.0	44.4	....	10.2
Number of bunches of radishes	23	24	26	28	28	29½	29	30½
Weight of radishes	1545	1816	1992	2319	2248	2014	1501	2617

* Making the amounts of nitrogen, phosphoric acid and potash the same as supplied to the first crop.

Third Crop.

From the weights and chemical analyses of the first and second crops was determined how much nitrogen, phosphoric acid and potash had been removed by them from the plots. These amounts (together with 6.6 grams of phosphoric acid in form of dissolved bone black) were applied to all the plots with exception of Nos. 72 and 73, before planting a third crop.

To plot 72, 88.8 grams of muriate of potash, equivalent to 44.4 grams of potash, and to plot 73, 120 grams of dissolved bone black, equivalent to 20 grams of phosphoric acid, were added.

The seed, of the same stock as that previously used, was sown precisely as before, on April 7th. It came up very evenly, and the crop was harvested between April 29th and May 6th.

TABLE XII. ANALYSES OF RADISHES. [ENTIRE PLANTS.]

	From Compost.	From Ashes and Peat.
Eight bunches weigh,	568 grams.	574 grams.
and contain,		
Nitrogen	.222 per cent.	.235 per cent.
Phosphoric Acid	.066 "	.048 "
Potash	.342 "	.235 "

Since the number of radishes from each plot depends upon the quality of the seed used and the weight depends almost entirely upon the age of the plants, no great stress should be placed upon either the number of bunches or the weight of crop in estimating the comparative profits of the crops. The weight of the crop from each plot was taken to enable us to determine from the analyses the exact amounts of nitrogen, potash, and phosphoric acid which it contained.

To grow radishes large enough for market in the shortest possible time is the market-gardener's aim. In these cultures the period of harvest covered nearly a week, the radishes being removed when large enough for market, while a commercial grower would doubtless clear the bench at one or, at most, two gatherings. In every instance the radishes grown in coal ashes and peat with chemical fertilizers reached marketable size earlier by one to four days than those grown in compost. The quality of the radishes was considered to be alike.

The third crop was the quickest to mature, and the second required less time than the first, doubtless because of the increase of solar energy.

Results of these cultures are :—

1. Radishes can be grown in coal ashes mixed with a little peat and carbonate of lime, by the aid of fertilizer chemicals, no less well and mature a little more quickly than in compost, and are quite as smooth, tender and crisp.

2. One thousand bunches of radishes, tops included, weighed 148 pounds and took from the soil:

5.2 ounces	**Nitrogen,**	**equivalent to**	**2 lbs. 1 ounce**	**Nitrate of Soda.**
1.6 "	**Phosphoric Acid,**	**"**	**10 ounces**	**Dissolved Bone Black.**
8.1 "	**Potash,**	**"**	**16½ "**	**Muriate of Potash.**

3. To raise 1000 bunches of radishes in a single crop there were required in our experiments, on the average, 518 square feet of bench space. The largest crop required but 414 square feet per 1000 bunches.

III. Carnation Cultures.

The space marked I in the southwest corner of the forcing house, figured on page 231, was divided into three plots, designated as A, B, C, each having an area of 7.08 square feet, which were planted to carnations.

Plot A was filled with the compost described on page 205, to which were added 29 grams of Nitrate of Soda, 14.8 grams of Muriate of Potash and 12.25 grams of Dissolved Bone Black.

Plot B was filled with anthracite coal ashes mixed with three per cent. of moss peat and 50 grams of carbonate of lime as described on page 205. Chemical fertilizers were added as follows: Nitrate of Soda 58 grams, Muriate of Potash 29.6 grams, Dissolved Bone Black 24.5 grams, these being double the quantities added to Plot A.

Plot C was filled with compost. All the plots had a good southern exposure. Plot C, at the southwestern corner, was perhaps more favorably situated as regards light than the others.

The plants were raised from cuttings taken in January, 1895. These were duly potted, and in May set in the open ground, where they remained until September, when thrifty plants were put in 5-inch pots and set in the ground for two or three weeks, and then removed to an unheated vegetation house. December 14th the plants were transferred to the forcing-house plots. Up to this time all flower buds had been pinched off; but the plants were now allowed to make single blossoms, all lateral buds being removed.

Carnations should be set in the benches during September, but owing to delay in finishing the forcing-house the crop could not

be started until very late. It will be seen that no liquid manures were given the plants, and this fact, together with the late setting, accounts for the small number of blossoms obtained.

The plants were of three varieties, Daybreak, Lizzie McGowan and Garfield. Three of each variety were placed in a plot, each plot containing nine plants.

Each plant was numbered, and the date of picking, diameter of blossom, and notes on shape, length of stem, etc., recorded up to May 1st. No observations were taken after this date, but the plants were allowed to remain in the benches, where they continued to blossom during the summer.

The table, p. 227, shows the yield of the plants up to May 1st. Had the observations extended over a longer period the yield would have been much larger, as the plants blossomed freely all through the summer.

No analyses of flowers or plants were made, so that the amounts of nitrogen, phosphoric acid and potash taken up by the plants and removed in the blossoms is not known.

A much more extensive experiment is now in progress, in the report of which these facts will be set forth.

These cultures prove that good carnations may be grown in coal ashes and peat with fertilizer chemicals, and that both the number and the average diameter of the flowers may be considerably greater than where a portion or the whole of the plant food is supplied by soil or manure. Thus, in one experiment, the number of flowers raised in coal ashes and peat, plot B, was more than three-eighths larger than that raised on compost, either alone or with fertilizer chemicals, plots A and C.

IV. Experiments with Cucumbers.

Plots Nos. 47–66 occupy the space marked O in the house figured on page 231.

In the fall of 1895, plots 47–55, on the east side of the center bench, were filled with a mixture of bituminous coal ashes and peat, and plots 57–66, on the west side, were filled with a rich compost.

All the plots containing ashes and some of those containing compost were dressed with fertilizer-chemicals and used during the winter of 1895–96 for experiments with lettuce.

The same plots were planted to cucumbers in the summer of 1896.

TABLE XII.—CARNATION CULTURES. YIELD OF BLOSSOMS.

	Plot A. Compost with Chemicals.			Plot B. Coal Ashes and Peat with Chemicals.			Plot C. Compost without Chemicals.		
Variety	Garfield.	Lizzie McGowan.	Daybreak.	Garfield.	Lizzie McGowan.	Daybreak.	Garfield.	Lizzie McGowan.	Daybreak.
No. of plants	3	3	3	3	3	3	3	3	3
No. of flowers previous to May 1st	19	5	7	21	12	16	19	6	3
Average diameter of flowers (inches)	1.96	2.05	2.07	2.04	2.25	2.07	1.84	2.19	2.08
No. of perfect flowers	18	3	7	21	10	14	16	5	3

To this end the quantities of nitrogen, phosphoric acid and potash removed in the lettuce crops from the plots filled with bituminous ashes and peat were replaced so that each plot contained in the residues and newly added fertilizers, 10.3 grams of phosphoric acid and 56.2 grams of potash in form of dissolved boneblack and muriate of potash.

Five plots received quantities of nitrogen ranging from 24 to 64 grams in form of nitrate of soda, and five other plots received like quantities of nitrogen in form of cotton seed meal.

To the soil of each of the compost plots were added 32 grams of nitrogen, 10.3 grams of phosphoric acid and 56.2 grams of potash, without regard to the quantities which had been removed in the lettuce crop.

Seeds of Arlington White Spine Cucumber were sown in flats May 1st. The seedlings, first put in two and one-half inch pots, were shifted in about two weeks to four inch pots, and were set, four in each plot, on June 1st.

The vines were allowed to spread on the soil, but were confined for the most part to the plots in which they were planted.

The glass required some shading during the summer and special care was given to maintaining abundant moisture in the air as well as in the soil.

Early in July plants growing in the coal ashes and peat were decidedly larger than those growing in compost, and those supplied with nitrate-nitrogen appeared thriftier than those supplied with nitrogen in form of cotton seed meal.

The first blossoms appeared on June 20th.

Flowers were hand-pollinated every other day until Aug. 1st. Bees were then abundant in the house and further hand-pollination was found unnecessary.

The first cucumbers were picked July 14th from plots 47, 51, 52, 61, 64, and 66, and the experiment was concluded on September 16th.

Only general results are here given, as the experiment is preliminary to a fuller study of the subject.

1. From 100 square feet of bench space, filled with rich compost, 85½ pounds of cucumbers were harvested. From an equal space filled with a mixture of bituminous coal ashes and peat 99 pounds of cucumbers were harvested.

The average weight of a single cucumber was 7.2 ounces in the former case and 7.4 ounces in the latter.

2. As a source of nitrogen, nitrate of soda and cotton seed meal were about equally efficient in the coal ashes and peat—(the yield was at the rate of 100 pounds per 100 square feet of space where nitrate was used and 98.8 pounds where cotton seed meal was used)—but with compost, cotton seed meal was decidedly more efficient (94.7 pounds per 100 square feet of space, while with nitrate of soda only 76.4 pounds were produced).

3. The fresh cucumbers contained:

	Raised on Compost.	Raised on Coal Ashes and Peat.
Nitrogen	0.095 per cent.	0.083 per cent.
Phosphoric Acid	0.053 "	0.032 "
Potash	0.222 "	0.207 "

From 100 square feet of bench space, the vines and roots took the following quantities of the ingredients named:

	Compost.		Bituminous Coal Ashes and Peat.	
	Per plot. grams.	Per 100 square feet. grams.	Per plot. grams.	Per 100 square feet. grams.
Nitrogen	5.69	38.7	4.54	30.9
Phosphoric Acid	1.20	8.2	0.61	4.1
Potash	12.08	82.1	7.77	52.8
Equivalent to		Ounces.		Ounces.
Nitrate of Soda	....	8.5	....	6.8
Dissolved Bone Black	....	1.8	....	0.9
Muriate of Potash	....	5.8	....	3.7

NEW FORCING HOUSE.

By W. E. Britton.

During the fall of 1895 the facilities for experimental work were increased by the erection of a forcing-house (see F, p. 231) fifty feet long and twenty feet wide, with an attached work-room, (G) 10 feet x 25 feet. A brief description of the house is here given, as we shall have frequent occasion to refer to the arrangement of it in the account of our experiments.

The house was designed and erected by Lord, Burnham & Co., of Irvington, N. Y. Running nearly north and south, with even span, this house is connected with the tomato house (see D and E, plate I) by a passage 5 ft. wide and 4 ft. long. The superstructure stands upon cast iron posts or foot-pieces, bedded in cement thirty inches below the surface of the ground. Bolted to

these foot-pieces are the wrought iron rafters, which are bent at the spring line and extend to the ridge, where they are fastened together by cast iron brackets.

Sash bars extend from the ventilating sash at the ridge to the spring line, being supported in the middle by an angle-iron purlin bolted to the rafters. The sash bars and all parts of the frame exposed to the weather are of cypress wood. Wooden cap-pieces are fitted over the iron frame so that no injury results from the contraction and expansion of the metal.

The glass used in this house is known to the trade as "second quality, double thick," and is 16x24 inches in size. The vertical walls are glazed above the benches on all sides. The ridge is 11 feet 6 inches and the spring line 4 feet 10 inches from the ground level.

Ventilation is secured by a continuous line of sash 30 inches wide on either side of the ridge and hinged to it, and a line of sash 24 inches wide extending the entire length of the west side, just above the bench.

Across the north end a lean-to (G) serves the purpose of a work-room. This is 10 feet wide and 25 feet long, and being glazed on the roof and sides, like the house itself, serves equally well as a house for growing stock plants. The floor of this lean-to is of cement, with a smooth surface, and can be used for mixing soils and fertilizers. This lean-to has a continuous ventilating sash, 30 inches wide at the upper angle of the roof, and hinged at the ridge. During the winter of 1895–96 the sections of benches indicated by the letters J, M and N, were used for growing stock plants.

This house is heated by steam brought from the central boiler which furnishes steam for all the Station buildings. The steam enters the house through an overhead pipe and returns through smaller pipes under the benches. Four pipes, divided into two coils and provided with valves, pass underneath each of the side benches. Under the center bench there are four coils of two pipes each, also furnished with suitable valves. This arrangement allows complete control of the temperature of the house.

The benches are 5¾ inches in depth and the side benches are 34 inches wide, with a space of two inches between the bench and the side of the house to permit the circulation of air. The center bench is 8 feet wide. Previous to starting any experimental work, the center and two side benches were temporarily divided into plots, having an equal area of 14.53 square feet.

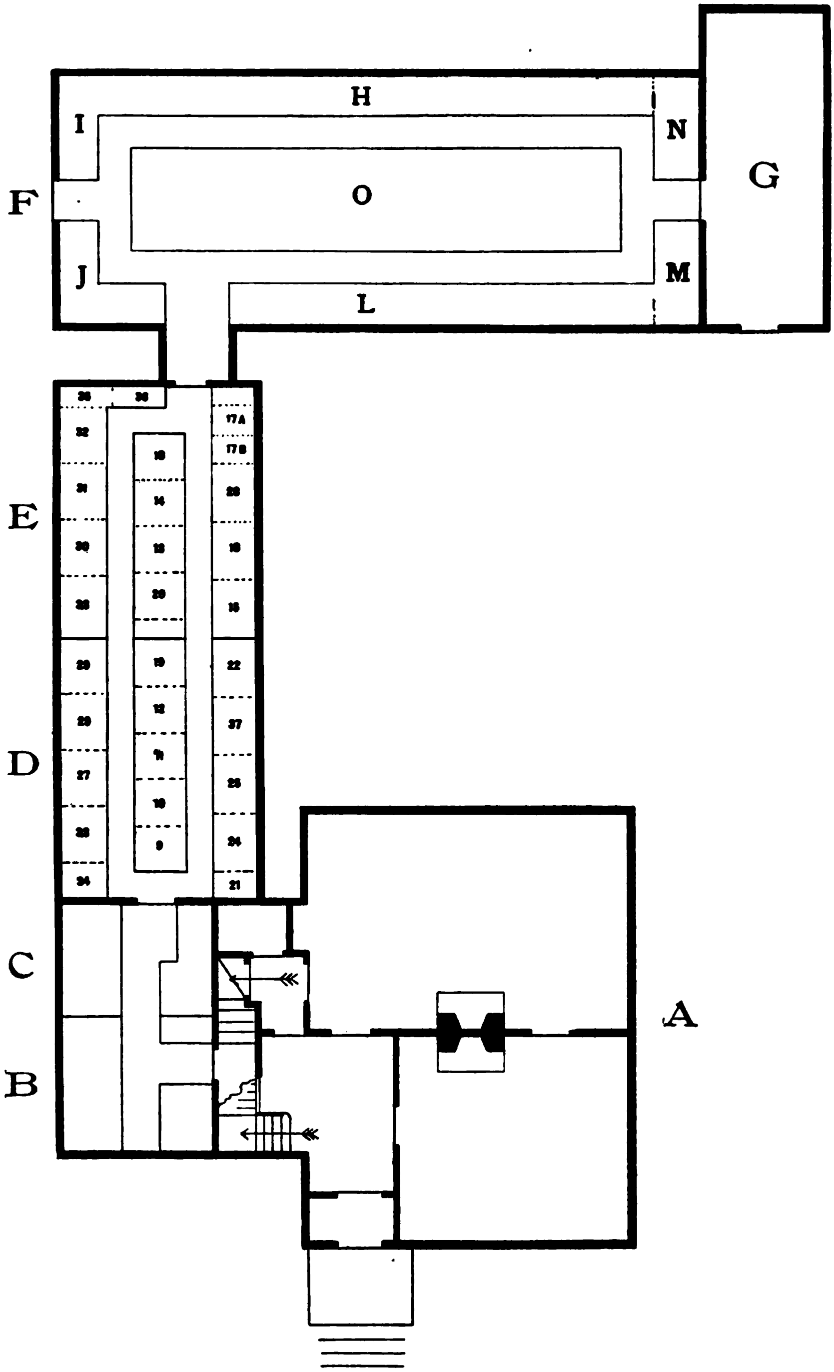


PLATE I. Plan of Forcing-Houses.

A, Botanical Laboratory; B, C, Small Plant Houses; D, E, Tomato Houses; F, New Forcing-House; G, Work-room.

BLIGHT, BURN OR SCALD OF TOMATO PLANTS.

By W. E. Britton.

On November 9th, 1895, during continuous cloudy weather, some of the tomato plants in one of our forcing-houses were affected with a blight which steadily increased from that date and made visible gain during periods of unbroken cloudiness and rain.

The blight first appeared on plots 9 and 10 of the cultures described on p. 205, soon after attacked the adjoining plots 11 and 12, and by January 14th, 1896, had nearly destroyed the plants on these four plots, which were all rooted in a mixture of coal ashes and peat, more or less enriched with fertilizer chemicals. Plants in other plots near by and in the same soil, as well as plants stationed in a good compost made of sods and stable manure, were but slightly injured.

The blight began at the tips of the lower leaves and gradually extended upon these leaves until they became entirely dead and dry, and also progressed upwards on the foliage. The uppermost, rapidly growing parts, remained longest unaffected, but finally all succumbed save the youngest leaves and terminals.

As the blight spread upon the leaves their color for a time was but slightly affected, faint concentric shades permanently marking each day's injury.

Many of the leaves that first suffered were, for a time, sheltered from direct sunshine by intervening healthy foliage.

After careful microscopic search, Dr. Sturgis decided that the injury was due neither to fungi nor bacteria. Samples of the leaves were sent to Dr. B. T. Galloway, U. S. Department of Agriculture, and to Prof. L. H. Bailey, of Cornell University, both of whom pronounced them affected with the burn or sun scald that commonly follows sudden exposure to bright sun following cloudy weather, or results from insufficient water supply to the roots, especially in case of plants which have been accustomed to warm moist air and abundant water.

Before setting the second crop there were added 24 grams of magnesium carbonate and 100 of calcium carbonate with the fertilizers, to plot 9, and 18 pounds of moss peat to plot 11.

Instead of furnishing nitrogen to plot 12 directly in form of nitrate, it was supplied by cotton seed meal mixed with a handful of garden soil to aid nitrification.

On March 6th the blight appeared on plots 9, 10, 11 and 12, and nowhere else in the house. Plot 12 had much less of it than either of the others and the trouble spread much less rapidly than in the case of the first crop. On March 24th, plot 11 showed most scald; plot 12 was almost free from it. Plot 9, which had been kept very wet, was not as badly affected as 10 and 11. On April 18th, just as fruit was beginning to ripen, the scald was much less prevalent than in the first experiment at that stage of growth. Plots 9 and 11 were more injured than 10 and 12, the last named plot being almost exempt. Plots 13 and 14 were not in the least affected, and their foliage was dark green and thrifty through the season.

Note by S. W. Johnson.

The burn or scald, as the blight is commonly designated, is without doubt simply a withering of the leaves due to loss of water by transpiration (surface evaporation), going on more rapidly than its supply can take place through the roots. The result is disorganization and death to the cells and tissues.

This injury began at the tips of the lower leaves for the same reasons that these parts are the first to become yellow or brown, dry and dead, in case of field or garden crops, when the season's growth is approaching a finish. The lower leaves are the oldest, ripest, of least vegetative vigor, and the first to succumb under adverse conditions. Their tips are furthest from the stem through which the water supply must come.

This kind of injury is most commonly observed when direct sunlight suddenly falls on the foliage of plants whose roots and the supporting soil are at a low temperature. Direct sunshine, i.e., warmed and illuminated foliage, immediately and greatly stimulates and increases transpiration, while cold roots are incapable of imbibing and cold stems of transmitting water with rapidity or at all.

In the present instance the blight is reported to have made visible progress under a continuously and densely clouded sky. The blight was also limited to the four plots, 9, 10, 11 and 12. These plots are situated at one end of the plant-house D, where its northeast corner is built into a right angle made by two high walls of the Botanical Laboratory. See Plate I, page 231.

This plant-house faces nearly south and is aired by a row of sashes hinged to the ridge over the south edge of the north

bench, and operated as a single ventilator. Because of this situation and construction, south and west winds are arrested, the air is banked up against the adjacent high walls and driven down through the ventilators, falling upon the affected plots as a very noticeable cold current which may chill the benches and lower parts of the plants sufficiently to reduce "root pressure" to the point where it cannot fully supply the loss of water occasioned by transpiration from the upper foliage, the latter being maintained at a relatively high temperature.

The chilling of the benches would occur more readily in rainy or cloudy weather than in dry, with the temperature unchanged, because moist air conducts heat more rapidly than dry air.

INSECT NOTES.

By W. E. Britton.

Canker Worms (*Paleacrita vernata*, Peck, and *Anisopteryx pometaria*, Harr.).—Canker worms were extremely numerous in some parts of Connecticut during the spring and early summer of 1896, and injured fruit and shade trees more seriously than for many years.

Many of the elms of New Haven lost a part of their foliage early in the season, the canker worms having nearly finished feeding before spraying operations against the elm-leaf beetle were begun.

On the Station grounds canker worms were abundant on apple, plum, cherry and hickory foliage, and were found feeding on the chestnut and the oak. Many adults were observed about the trunks of these trees during the warm days of November and December, 1895, and most of the injury here was caused by the Fall canker worm, *A. pometaria.*

In Cheshire and elsewhere the foliage of apple orchards was completely ruined. Many farmers apparently failed to notice the presence of the caterpillars until their trees were partially defoliated, and those who then begun to spray were too late to get much benefit.

The two common kinds of canker worms closely resemble each other, but are distinguished by the time of the appearance of the adults or moths. The Fall canker worms reach the adult stage in fall or early winter. Spring canker worms mostly transform to moths in the springtime.

Their habits otherwise are identical, and they may be easily recognized by the manner in which they "spin down" from the tree when they are disturbed.

The larva of the Spring canker worm has only two pairs of abdominal pro-legs, the fifth abdominal segment being smooth. The Fall canker worm larva has three pairs of these legs, one pair being borne upon the fifth abdominal segment. This is the chief difference between the larvæ of the two species.

The females are wingless in both species, and crawl up the trunks of trees to deposit their eggs, clusters of which may be found in the crevices of the bark.

The eggs of both species hatch in spring at the time when trees are leafing out. The caterpillars are of a greenish color at first, and assume a brownish color as they increase in size. In from three to four weeks the caterpillars become full grown, and are then about an inch in length, and of a dark brown color with lines of lighter color running lengthwise, the color as a whole varying considerably. The adult males of both species are moths of an ash-gray color, with indistinct markings of black and white. The wingless females are similar in color. Both species pupate in the ground. See Plate II.

The same methods serve for combatting both species. Obstructions placed about the trunk of the tree, to prevent the wingless females from ascending to lay their eggs, are effectual preventives. Paper or cloth bands covered with tar or printers' ink are commonly used. Metal troughs filled with oil are of service if properly applied and kept clean.

The most satisfactory method of destroying the caterpillars is to spray the foliage with arsenical poison. Some orchardists have found difficulty in killing the caterpillars by spraying, but if they are attaked when young they are easily destroyed. After the tree has been nearly defoliated there is little use in applying poisons.

According to Bailey,* a mixture of 1 lb. of Paris green, 2 lbs. of lime, fresh slacked, and 200 gallons of water gives the best results. Lead arsenate (made by mixing eleven ounces of sugar of lead (lead acetate) and four ounces of arsenate of soda with 150 gallons of water) remains in suspension better than Paris green and is less liable to injure foliage.

* Cornell Experiment Station, Bulletin 101.

THE ARMY WORM (*Leucania unipuncta*, Haw.).—During the summer of 1896, the Army worm was quite abundant and the cause of much injury throughout Connecticut. A five-acre oat field upon the grounds of the School for Deaf Mutes at Hartford was attacked early in July and stripped of leaves. A portion of the oats were cut, whereupon the worms ate off the heads, leaving nothing but the straw. The writer saw the field on July 9th. The larvæ were then either nearly full grown, or had already pupated. At one place the ground was so covered that every step there would crush ten or twelve of the worms, and the noise of their movement could be distinctly heard. Kerosene oil sprinkled upon them killed the small worms. The full grown larvæ managed to crawl away, though it is doubtful if they transformed and came forth as adults. On July 10th, the writer saw a rye field at Springdale which had been devastated in a similar manner. Most of the worms here had pupated and not so many were seen, though a good illustration of their work remained. Furrows had been plowed around the infested field in order to prevent the larvæ from attacking adjacent grounds. Considerable damage was reported from the vicinity of Stamford and Norwalk.

A second brood appeared early in September. On the 5th, at the farm of Mr. George Bradley of Fair Haven, the writer found the larvæ abundant in all sizes from the newly-hatched to full grown, feeding upon a field of Hungarian grass. Nearly all of these larvæ were parasitized, by a Tachina fly, see *d*, plate III, whose eggs had been deposited just back of the head. These eggs hatch in a few hours and the young grubs make their way into the body of the Army worm, and there feed and develop. The host lives just long enough for the parasites to become full grown and then dies. That the relation proves fatal to the host, was well shown by the fact that of 17 parasitized larvæ collected on September 5th, only 7 were alive on September 9th.

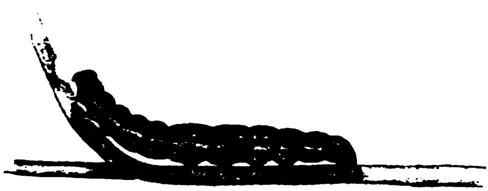
The adult of this insect is a light-brown moth whose spread of wings is about one and three-fourths inches. The insect in all its stages resembles the cut worm, to which it is closely related. Usually its habits are like those of cut worms, except occasionally when it becomes so abundant as to move in armies.

The larva is about one and one-half inches long when full grown, and is without hairs. It is rather dark in color with indistinct stripes of green and white running the full length of

Plate II. Fall Canker Worm, ***A. pometaria.***

Adult male and female—natural size (original).

a



b

c

d

Plate III. Army Worm, ***L. unipuncta.***

***a*, Adults—from photograph; *b*, larva; *c*, pupa—from drawings. All natural size (original).**

***d*, Parasite of Army Worm. (Riley. Circular 4, second series, Division of Entomology, United States Department of Agriculture.)**

the body. This is the stage in which the insect is supposed to live through the winter; larvæ of the last brood becoming sluggish when about half grown and concealing themselves in any convenient place of shelter. In the eastern part of Massachusetts, the egg is thought to be the hibernating stage.*

Larva, pupa, and adults, are shown in Plate III.

The eggs are deposited by the adults among the leaves and stubble of grain and grass. It is said that a single female may yield from five to seven hundred eggs.† The eggs hatch in about ten days, and the larvæ feed upon plants of the grass family for about four weeks; they are then full grown and go into the ground to pupate. The pupa is dark brown in color, and about three-fourths of an inch in length. The insect remains in this stage two weeks, then the adult moth appears. There are at least two broods in Connecticut, and probably more. Weed‡ concludes that there are three broods in New Hampshire. During 1896 invasions of the Army worm were reported from Massachusetts, Pennsylvania, New York, New Hampshire, Vermont, Michigan and Iowa. The New York invasion is said to have been one of the worst in the history of that State.§

The treatment commonly recommended is to surround the infested field with a deep furrow having a perpendicular outer edge. The larvæ are unable to ascend, particularly if the surface is smooth, and will fall back into the furrow, where they may be destroyed. A convenient method is to dig holes at short intervals in the bottom of the furrow. The caterpillars in trying to get out will travel along the furrow and fall into the holes, where they may easily be crushed or destroyed with kerosene. The armies usually move in straight lines and enter fields through gate-ways instead of climbing fences. This habit should be taken advantage of in fighting them, for it is often possible to obstruct their progress while occupying only a small corner of a field, and they can then be destroyed much more easily than when scattered over a large area. Poisoning the grass directly in front of the army is also to be advised. In case of an outbreak it is necessary to act quickly, for a delay of a day or two often results in much injury.

* Mass. Hatch Exp. Station, Bulletin 28.

† Dr. C. V. Riley, Report of Entomologist, U. S. Dep't., Agr'l. Report 1881–2, p. 92.

‡ New Hampshire Agr. Exp. Station, Bulletin 39, p. 67.

§ New York Agr. Exp. Station, Bulletin 104.

It is hardly probable that an attack will occur in 1897. It is seldom that the Army worm is seriously destructive during two successive seasons. Natural enemies usually hold it in check. The great number of parasitized larvæ found in September is an indication that the parasite will be sufficiently abundant to take care of the Army worm the coming season. A dozen eggs were found upon a single larva. These were probably eggs of the Tachina fly, which is perhaps the most important parasite. There is also a bacterial disease that destroys the Army Worm in great numbers, and several species of birds prey upon the larvæ.

CURRANT STEM-GIRDLER (*Phyllœcus flaviventris*, Fitch). — In March a communication was received from Mr. George W. Peabody, of Windham, relative to an insect that injured his currants by cutting off the tips of the new growth about the middle of June. A visit to the field was made June 20th. A half acre of currant ground was infested to such an extent that from fifteen to thirty tips per plant had been cut by the insect. Some of these tips had fallen to the ground, while others still hung in a wilted or dried condition. Mr. Peabody states that his currants have been injured in this manner for four successive seasons, and that on account of the injury he has not been able to obtain good wood for propagation. Another effect is to lessen the crop of the following season by destroying a portion of the fruit-bearing canes.

The work of the insect was also observed in Berlin, Cheshire, Hamden, and New Haven, but in none of these places was the injury as great as at Windham.

The author of the injury is a slender four-winged fly. The adult deposits eggs in the soft new growth, about the middle of June. The ovipositor is thrust about half way through the stem and the egg is usually found in the heart of the tender pith. A few slanting cuts are made in the stem just above the point where the egg is placed, the tip droops and further growth ceases. As the tips become dry and brittle they break off and drop to the ground. The egg is usually found in the center of the stem about three-fourths of an inch below the cut. It is not definitely known whether the egg is deposited before the cut is made or afterwards. The young larva feeds upon the soft pith, and slowly descends inside the stem, becoming full-grown in the autumn. A thin cocoon is then formed, in which the insect passes the winter. In the spring the larva changes to a pupa

PLATE IV. CURRANT STEM-GIRDLER, *P. flaviventris.*

a, Egg puncture: *b*, section of stem, showing egg in pith; *c*, severing of terminal by female; *d*, egg—greatly enlarged. (Marlatt, Insect Life, Vol. VII, Division of Entomology, United States Department of Agriculture.)

and the adult comes forth from the middle to the last of May. The incisions are probably made with the insect's mandibles,* and are from two to three inches below the tip. See Plates IV and V.

This insect is considered to be a native of North America, where it formerly bred in wild currants. During the last four or five years it has attacked cultivated plants, and attention has occasionally been called to it as a destructive insect.

The best treatment is to clip off the young shoots, in June, one or two inches below the point where the incision has been made. The severed portions drop to the ground, dry, and the newly hatched larvæ are thus destroyed.

Gathering and burning the tips of the canes containing the larvæ, in fall or early spring, is the only other remedy that can now be suggested. If this be practiced thoroughly for a few seasons, the injury will be much lessened.

THE FRUIT BARK BEETLE (*Scolytus rugulosus*, Ratz.).—Though the Fruit Bark Beetle or Shot-hole Borer, as it is sometimes called, has been the subject of two notes in previous reports of this Station,† a somewhat different method of attack has been observed the past season, and again the attention of orchardists is called to this destructive insect.

So far, in this State, the greatest injury has been inflicted upon peach trees, but it has also been found upon the plum and cherry. It is known to attack plum, cherry, apricot, peach, pear, apple, quince, and, of ornamental trees, the elm, mountain ash, and European hawthorn.‡

The Fruit Bark Beetle is a native of Europe, and was first noticed in this country at Elmira, N. Y., in 1877. In 1888 it was found in Illinois,§ but had previously been observed by Prof. Atkinson in South Carolina.‖

On June 20th, a visit was made to the orchard of the Connecticut Valley Orchard Co., at Berlin. A few plum and cherry trees in one corner of the orchard, and somewhat removed from other trees, appeared much as if affected with the so-called "fire-blight." Young twigs were dead and the foliage had turned black. Upon examination it was found to be the work of an

* Insect Life, Vol. VII, p. 387.

† Report of Conn. Agr. Exp. Station, for 1894, p. 142, and for 1895, p. 191.

‡ Illinois Agr. Exp. Station, Bulletin 15, p. 473.

§ Ibid, p. 469.

‖ South Carolina Agr. Exp. Station, Bulletin 4.

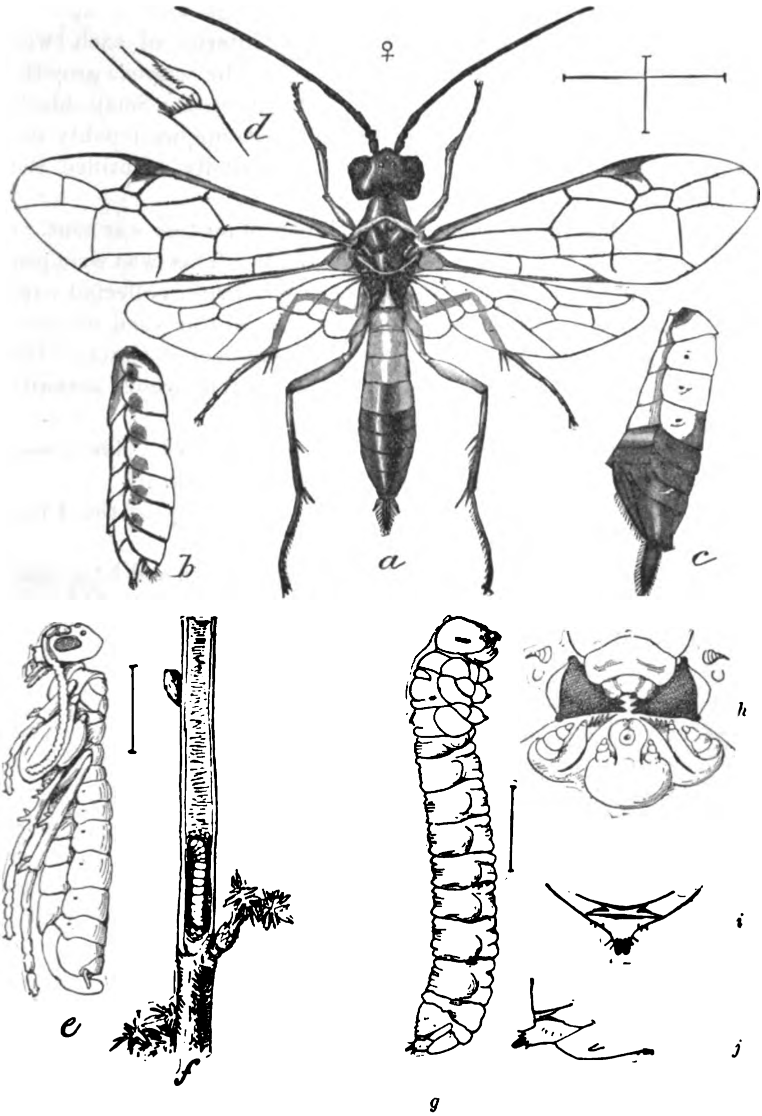


PLATE V. CURRANT STEM-GIRDLER, *P. flaviventris*.

a, Adult female; *b*, lateral view of male abdomen; *c*, do. of female; *d*, apex of anterior tibia of female; *e*, pupa; *f*, larva in twig; *g*, larva; *h*, mouth parts of larva; *i*, dorsal view of tip of abdomen; *j*, lateral view of same. (Marlatt, Insect Life, Vols. VI and VII, Division of Entomology, United States Department of Agriculture.)

insect. A large bunch of these infested twigs was brought to this Station and carefully examined. The interior of each twig was eaten out at the base of young shoots of the season's growth, and many twigs had broken over and withered. Small black beetles emerged from the cavities and were unquestionably the cause of the injury. Dr. L. O. Howard kindly identified the insect.

In July a section of wood from a Japan plum tree was sent to this Station by Mr. N. S. Platt, of Cheshire. This was wrapped in paper and placed in the laboratory. The writer collected over sixty beetles which emerged from a portion of the wood scarcely ten inches long and two inches thick. Some bored through the paper wrapping and escaped, so that the number which actually came from the wood is not known.

This insect and its work are shown in Plate VI. The insect passes the winter in the larval stage under the bark.

According to Prof. J. B. Smith,* the life history of the Fruit Bark Beetle is briefly as follows:

"The black parent beetles appear in early spring, and bore little round holes through the bark to the sap-wood. There they make a central burrow, on each side of which little notches are made to receive the soft white eggs. The larvæ hatch very soon, and at once begin to make little burrows of their own, diverging as they move from the parent channel, and gradually enlarging them as they increase in size. When full grown they form a slightly enlarged chamber, in which they pupate, and when they transform to beetles make their way out through little round holes in the bark. The whole period of development does not exceed a month, and there may be several broods during the summer from the same tree, the numerous galleries eventually girdling and killing it."

Usually only trees are attacked which are diseased or have in some way become weakened.

Troop states† that he has observed the injury on trees that apparently were perfectly healthy.

Trees badly infested should at once be destroyed. If the attack is only slight the tree can probably be saved by spraying the trunk and branches with Bordeaux mixture or whitewash to which a little Paris green has been added. This treatment has

* Economic Entomology, p. 238, 1896.

† Purdue Univ. Agr. Exp. Station, Bulletin 53, p. 128.

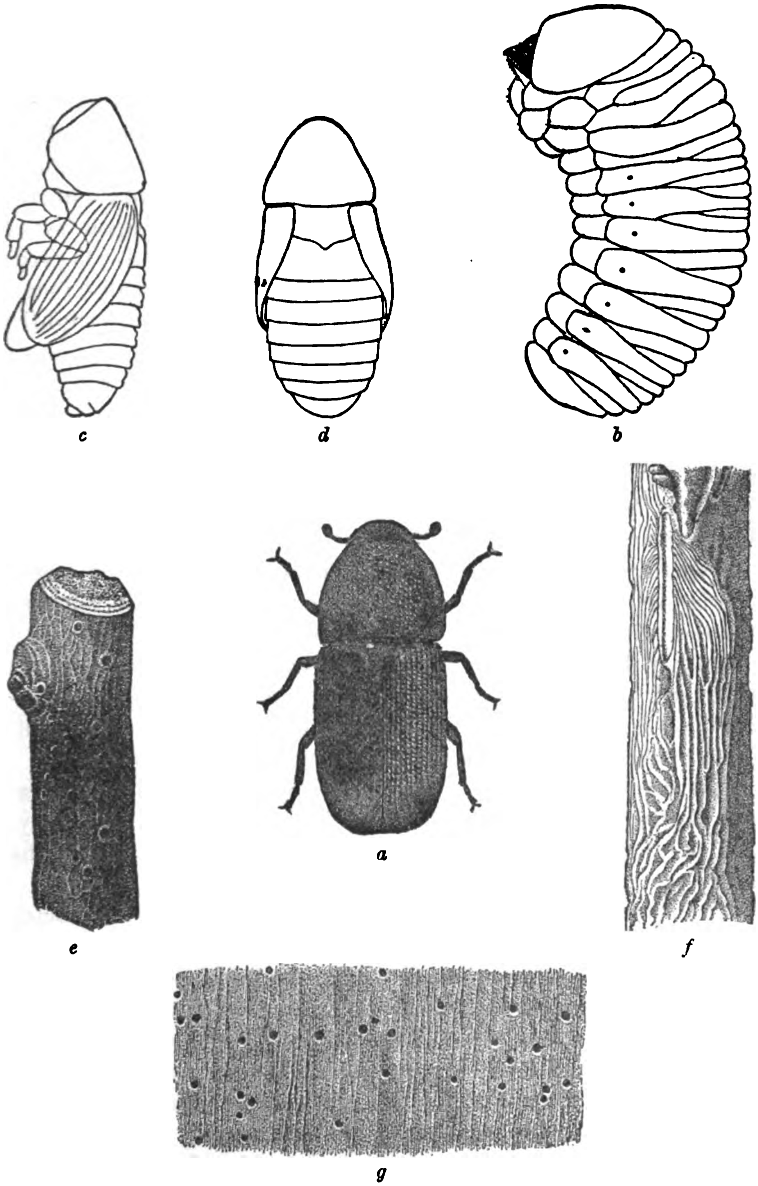


PLATE VI. FRUIT BARK BEETLE, *S. rugulosus.*

a, Adult; *b*, larva; *c*, *d*, pupæ—greatly enlarged; *e*, branch of peach, showing perforations; *f*, branch with bark removed, showing tunnels; *g*, perforations in large branch of plum. (Forbes, Bulletin 15, Illinois Agri. Exp. Station.)

been reported effectual by some experimenters. As the most vigorous trees are usually exempt from attack, anything that will promote health is to be recommended. Good cultivation and liberal fertilizing are safe preventives.

THRIPS (*Heliothrips cestri*, Pergande).—Hothouse cucumbers are sometimes infested with small insects about one-twentieth of an inch long, that jump or fly about with great agility and are known as "thrips." They are sometimes found upon other plants such as the Fuchsia, Gardenia, Hydrangea, and Chrysanthemum. On cucumber plants, the "thrips" are usually found upon the under side of the leaves. A spotted appearance slightly different from that caused by "red spider" is an indication of the presence of the insect. The infested leaves finally turn yellow and die.

Specimens collected in the Station greenhouse were sent to the U. S. Department of Agriculture and pronounced *Heliothrips cestri*, by Mr. Pergande, Assistant Entomologist, who had previously named and described it.*

Experience in the Station greenhouses, shows that the insect can be kept in check by fumigating occasionally with tobacco. Contact with kerosene emulsion proves fatal to it.

During the winter Mr. T. J. Stroud, of Shaker Station, wrote that the "thrips" were injuring his cucumber plants. An application of kerosene emulsion was advised and proved successful. Most of the insects were killed by a single application.

ASPARAGUS BEETLE (*Crioceris asparagi*, Linn.).—The asparagus beetle was unusually abundant last season in this vicinity, and the larvæ injured the asparagus plants by devouring the foliage.

The beetle is about a quarter of an inch in length, and of black color with red and yellow markings. It is in this stage that the insect passes the winter; in the spring the female eats holes and lays eggs in young asparagus shoots. As soon as the eggs hatch the young larvæ commence to feed upon the tender shoots. The larva is a slug of grayish color with black head and brown legs.

A later brood attacks the full-grown plants, but if these are sprayed with Paris green or lead arsenate, serious injury will be prevented. Hellebore is said to be effectual. Any fine powder dusted upon the plants will tend to asphyxiate the larvæ by closing their breathing pores. This treatment is good to hold the insect in check.

* Insect Life, Vol. VII, pp. 390–395.

Comstock writes*: "Where this pest occurs care should be taken to destroy all wild asparagus. This will force the beetles to lay their eggs upon the shoots that are cut for market; the larvæ hatching from such eggs will not have a chance to mature."

The asparagus beetle came from Europe about 1859. It first appeared in the vicinity of New York, where it became very troublesome and soon extended to other states.

There are several broods during the season.

* Manual for the Study of Insects, p. 576, 1895.

EXPERIMENTS ON THE PREVENTION OF POTATO-SCAB.

By Wm. C. Sturgis.

Having demonstrated by the result of the experiments of the past two years the feasibility of securing, by the use of corrosive sublimate, a practically clean crop of tubers from seed however scabby, providing only that the seed be planted on land not infested with the scab-fungus, and be fertilized with fertilizer chemicals, it seemed advisable to test the efficacy of certain other fungicides, notably sulphur, which gave good results in New Jersey, and a material known as "Lysol" and highly recommended in Europe as a germicide. As obtained from Messrs. Eimer & Amend of New York City, lysol is a heavy brownish liquid with a strong odor of creosote. It mixes readily in water, and when so mixed forms a cloudy, opalescent liquid resembling dilute soap-suds.

In France and Germany it has been recommended as a powerful antiseptic, neither corrosive nor toxic in dilute solutions, of stable composition, and superior to all others for disinfecting wounds, surgical instruments, buildings, etc.* For such purposes ½%–5% solutions are used. As long ago as 1893, French experiments proved the efficacy of 2% solutions of lysol in preventing the invasion of mushroom beds by parasitic fungi;† later it came into prominence as an insecticide, particularly in the case of plant-lice and slugs.* Solutions of ¾%–2% proved thoroughly efficacious in destroying not only soft-bodied insects such as plant-lice, but even scale-insects, and that without damage to the plant even in 2% solutions.‡ For the closing of wounds on trees, and assisting the natural healing process, lysol in a 5% solution is said to be far superior to tar or grafting-wax.‡ Finally it is stated repeatedly that ½%–1% solutions will prevent the mildew of roses and grapes as effectively and more cheaply than Bordeaux mixture, and without damage to the plants.§ As compared with Bordeaux mixture, lysol has the advantage, according to a French writer,§ of being

* Revue Mycologique, XVII–68, p. 184, Oct. '95.

† Cf. Rev. Myc., XVI–62, pp. 61 & 62, Apr. '94.

‡ Zeitschrift für Pflanzenkrankheiten, V–4, pp. 252 & 253, '95.

§ Cf. Centrabl. für Bakteriologie, Parasitenkunde, u. Infektionskrankheiten, II–4, pp. 133 & 134, '96.

a combined insecticide and fungicide 28% cheaper than Bordeaux mixture, and he estimates that the substitution of lysol would mean an annual gain to the vineyardists of France of 15,000,000 francs ($3,000.000).

If these statements are trustworthy, and we have no reason to suppose the contrary, we have in lysol an agent of extreme value in the treatment of plant-diseases, one well worthy of repeated trial. The successful preparation of Bordeaux mixture assumes some skill and judgment on the part of the operator, time is unnecessarily consumed, and in inexperienced hands the application is often incomplete and unsatisfactory. Lysol, on the other hand, is a liquid; it mixes readily and immediately with water; in applying it there is none of the inconvenience caused by a clogged nozzle. The cost of lysol is a matter for serious consideration. It is retailed in New York in pint bottles at 60 cts. a pound (1 pint). This quantity is sufficient to make 25 gallons of a ½% solution. With copper sulphate at 6 cts. per lb., and lime at $1.65 per bbl. and using the 6–4–50 formula, Bordeaux mixture costs about 20 cts. for 25 gallons. Allowing for the addition of Paris green at 25 cts. per lb., in the proportion of 1 lb. to 100 gallons of the Bordeaux mixture, the latter will cost about 32 cts. for 25 gallons, as compared with 60 cts. for the same quantity of a ½% lysol solution. This can hardly be reconciled with the statement made by the French writer above referred to, regarding the relative cheapness of lysol. His figures, however, are based upon a much lower price of the pure material. Lysol is sold in cans in Paris at 2 francs per kilo (2.2 lbs.), or about 18 cts. per lb. as compared with 60 cts. per lb. in New York. At the latter figure the use of lysol as a fungicide is practically prohibited except by way of experiment. Nevertheless the statements concerning its value are so unqualified that a careful test of its properties seemed advisable.

It was decided to make the test upon potato-tubers either themselves infested with scab or planted in soil so infested. This seemed to promise the fairest basis for conclusions, since the treatment for potato-scab at present in use is antiseptic in character, and it is as an antiseptic that lysol is especially recommended. An experiment in continuation of those of previous years, to test the value of corrosive sublimate in this connection, had also been planned, and the use of the two materials side by side would, it was thought, give a fair basis of comparison. As regards the

comparative cost of the two, the small amount of material used in treating seed potatoes as compared with any method involving the spraying of plants, makes a difference in the price of the crude materials hardly worth considering. As a matter of fact however, lysol is again seen to be the more expensive. Twenty-five gallons of a corrosive sublimate solution, with that chemical selling for 10 cts. per oz. and used in the proportion of 2¼ oz. to 15 gallons of water, cost about 42 cts. as compared with 60 cts. in the case of lysol.

Four sets of experiments were undertaken in different localities and under various conditions to test the value of chemicals in preventing scab. Of these experiments one had to do with ascertaining the susceptibility to scab of various root-crops and the efficacy of treating the soil in order to free it from the germs of the scab-fungus. Another had for its aim a comparison of corrosive sublimate and lysol as preventives of scab upon potatoes. The remaining two involved other questions, the comparative efficiency of lysol being merely incidental. We will therefore consider first the second of the experiments mentioned above.

Experiment I.

The Comparative Value of Corrosive Sublimate and Lysol in preventing Scab upon Potatoes.

This experiment was conducted on the Station grounds upon a piece of land which had not recently borne either potatoes or root-crops, and was therefore presumably free from the scab fungus. The seed used was completely infested with scab. It had been stored in a warm, fairly dark cellar, and by May 8th, the date of planting, all of the tubers had sprouted. The sprouts on some of the tubers were short, stocky and green; those on the remainder were from four to eight inches long, spindling and etiolated. Leaf-buds were beginning to start on some of the sprouts. The tubers were washed, divided into five lots and treated as follows:

Lot 1. Soaked in 1% Lysol solution, 1½ hours.
Lot 2. Soaked in ½% Lysol solution, 1½ hours.
Lot 3. Soaked in $\frac{1}{10}$% Lysol solution, 1½ hours.
Lot 4. Soaked in Corrosive Sublimate solution (1 oz. to 6 galls.), 1½ hours.
Lot 5. No treatment. (Check.)

After treatment the seed potatoes were spread out to dry, the effect of the solutions, especially on the sprouts, was noted, and the tubers were then cut and planted as usual.

The external effect of the lysol was very marked. In the case of the two stronger solutions the etiolated sprouts were colored pale brownish-red or pink, especially where bruised or cut, and the same color was observable in the liquid after the tubers were removed. The green, stocky sprouts were uninjured except that the young leaf-buds were blackened. The surface of the tubers themselves showed no sign of injury. With the $\frac{1}{10}$% solution, although it showed a discoloration similar to that observed in the other two after contact with the tubers, the latter were uninjured even when the sprouts were long and etiolated and showed green leaf-buds. With the corrosive sublimate, as was expected from the results of the experiment of last year, no injury was observable on the sprouts.

Observations made on the growth of the plants showed no very marked irregularities, except in the case of the seed treated with 1% lysol. The plants in this row were three or four days later in appearing above ground than any of the others, a few hills failed entirely, and the crop was light and composed of very small tubers. The 1% solution of lysol had evidently done serious injury to the seed. It is possible that the result would have been different had the seed-tubers not been sprouted.

Potato-bugs began work early and in great numbers, thus giving abundant opportunity for testing the insecticidal qualities of lysol. Each of the three rows in which the seed had been treated with lysol were sprayed twice with lysol of the same strength as that used on the seed. The spray was applied in sufficient quantity to drench the plants but produced no perceptible diminution in the number of bugs. Colonies of young, soft-bodied bugs were soaked with the 1% solution without apparent injury, and the lysol was therefore discontinued after the second spraying, and a dry Bordeaux mixture prepared by Messrs. Hotchkiss Bros. of Wallingford and mixed with Paris green, was substituted. This checked the bugs in a measure, but the vines had been injured beyond recovery and died three weeks before those on the two adjoining rows. Of these two, the row which had been reserved as a check was dusted twice with the dry Bordeaux mixture mentioned above, mixed with Paris green. By this

means the plants were kept comparatively free from bugs, but early in August the "early blight" appeared, and though a spray of the Bordeaux mixture was at once substituted for the dry form, the blight spread slowly and eventually destroyed the vines. On the remaining row treated with corrosive sublimate, Bordeaux mixture made according to the usual formula was used from the beginning. Three applications were made, the vines remained free from bugs throughout the season, and showed only a few traces of blight.

The potatoes were all dug Aug. 28th. The general lack of vigor on the part of the plants, shown by their short period of growth and poor returns, was doubtless due in large measure to the character of the seed which, besides being covered with scab, had given up much of its remaining vitality to the sprouts; while the latter, grown largely in the dark, were unfit to produce plants of much vigor. After being dug, the potatoes from each row were separated into three grades depending upon the amount of scab present upon them. The results are shown in the following table:

TABLE I. COMPARATIVE EFFICIENCY OF LYSOL AND CORROSIVE SUBLIMATE AS PREVENTIVES OF POTATO-SCAB.

	Treatment.	First Quality.	Second Quality.	Third Quality.	Total Yield.
Row 1	Not treated, Check	7 lbs. 5 oz.=32%	11 lbs. 4 oz.=49%	4 lbs. 8 oz.=19%	23 lbs. 1 oz.
Row 2	Lysol, $\frac{1}{10}$%	10 lbs. 14¼ oz.=40%	11 lbs. 14½ oz.=44%	4 lbs. 7½ oz.=16%	27 lbs. 4¼ oz.
Row 3	Lysol, ½%	9 lbs. 3 oz.=55%	6 lbs. 3½ oz.=38%	1 lb. 3 oz =7%	16 lbs. 9½ oz.
Row 4	Lysol, 1%	13 lbs. 10 oz.=78%	3 lbs. 14½ oz.=22%	0	17 lbs. 8½ oz.
Row 5	Corrosive Sublimate, ½ oz. to 3 galls.	25 lbs. 12½ oz.=89%	3 lbs. 5½ oz.=11%	0	29 lbs. 2 oz.

The advantage attending the use of corrosive sublimate under the conditions outlined above, viz.: when the seed itself presents the only source of contagion, is seen at a glance. Notwithstanding the fact that Row 5 was only 39 ft. long as compared with 54 ft. in the case of the other rows, it shows the highest total yield. This is to be attributed rather to the preservation of the vines by means of Bordeaux mixture than to the treatment of the seed, but it is of interest in that connection. As to the

immediate effect of the treatment of the seed, the only row which shows an approach to the good results obtained from the use of corrosive sublimate, is that treated with 1% lysol solution. Neither row shows any very scabby tubers in the crop and the lysol produced only 11% less tubers of first quality and 11% more tubers of second quality than did the corrosive sublimate. But we have already seen indications that lysol of a concentration stronger than $\frac{1}{10}$% injures seed-potatoes, those at least which have sprouted before treatment. These indications are borne out by the results, the crop resulting from the use of $\frac{1}{10}$% lysol being much greater than that obtained with the stronger solutions, and only slightly less than that secured with corrosive sublimate. As to the quality of the crop it will be seen that the percentage of first-quality tubers increases, and the percentage of second and third-quality tubers decreases, with the increased strength of the lysol solution; and this ratio holds good throughout the series, the check row showing returns of the poorest quality, the corrosive sublimate row showing the best, and the lysol increasing in efficacy with the strength of the solution.

From the results thus obtained we may summarize our conclusions as follows:

(1) Corrosive sublimate continues to hold its own as a preventive of potato-scab in cases where the seed is the only source of contagion.

(The results obtained in this instance are very remarkable considering the fact that the seed used was so completely infested with scab that not a single tuber showed a square inch of clean surface.)

(2) As a preventive of potato-scab lysol is distinctly inferior to corrosive sublimate. A solution of $\frac{1}{10}$% is not sufficient to secure disinfection of the seed, while solutions of ½% and 1% injure the seed, at least when the latter is sprouted, and therefore lessen the crop very materially.

(3) As an insecticide, in the case of potato-bugs, lysol possesses little value as compared with Paris green, and is besides much more expensive.

(4) As a fungicide lysol fails to check the early blight of potatoes.

(5) Dry Bordeaux mixture mixed with Paris green and dusted on potato plants, is inferior both as a fungicide and an insecticide, to Bordeaux mixture used as a liquid spray.

Experiment II.

The Comparative Value of Corrosive Sublimate, Lysol, and Sulphur in preventing Scab upon infested Land.

This experiment was conducted at South Manchester on land occupied for the past two years by potatoes. The piece of land selected was a portion of Plot B of last year's experiment. This plot produced a crop of which 75% was scabby; the soil was therefore presumed to be thoroughly infested with the fungus. It was divided into two equal parts, on one of which scabby seed was used and on the other clean seed. A blank space, ten feet wide, separated the two portions. The potatoes were planted in twelve rows each 20 feet long, and before being cut and planted received the following treatment:

Row 1. Washed in water. Check.
Row 2. Soaked 1½ hours in Lysol solution, $\frac{1}{10}$%.
Row 3. Soaked 1½ hours in Lysol solution, ½%.
Row 4. Soaked 1½ hours in Lysol solution, 1%.
Row 5. Washed. Rolled in Sulphur. Sulphur sown in each hill.
Row 6. Soaked 1½ hours in Corrosive Sublimate solution, ½ oz. to 2½ galls.
Rows 7–12 inclusive received the same treatment respectively, but reversed in order of planting.
Rows 1–6 were planted with seed free from scab; rows 7–12 with scabby seed.

The experiment was expected to give additional information on the following points:

1. The effect of planting clean seed and scabby seed, not treated, on scabby land. (Rows 1 and 12.)
2. The effect of treating clean seed and scabby seed with lysol solutions of different concentrations. (Rows 2–4 and 9–11.)
3. The same, sulphur being used as the disinfecting agent.
4. The same, corrosive sublimate in solution being used.

The clean potatoes were treated, cut and planted on May 15th, the scabby potatoes on May 18th. No visible injury resulted from any of the lysol solutions. On June 5th the plants in the two check-rows, the rows treated with sulphur and those treated with the two weaker solutions of lysol, were appearing above ground. The remaining rows started two days later, but all grew rapidly and at the close of the season showed no perceptible difference in vigor. Paris green served to check the potato-bugs, and though the early blight appeared, the attack was not sufficiently severe to impair the results. On September 14th one-half

of each row was dug; the rest remained untouched until October 20th in order to test the possible advantage of early digging in cases where scab had already attacked the crop.

The results obtained September 14th are given in the following table:

Table II. Corrosive Sublimate, Lysol, and Sulphur as Preventives of Potato-Scab on Infested Land. Sept. 14th.

	Treatment.	1st Quality.	2d Quality.	3d Quality.	Total Yield.	
Row 1	No treatment Check	8 lbs.=44%	7 lbs.=39%	3 lbs.=17%	18 lbs.	Clean Seed.
Row 2	Lysol, $\frac{1}{10}$%	5 lbs.=50%	3.5 lbs.=35%	1.5 lbs.=15%	10 lbs.	Clean Seed.
Row 3	Lysol, ½%	7 lbs.=52%	4.5 lbs.=33%	2 lbs.=15%	13.5 lbs.	Clean Seed.
Row 4	Lysol, 1%	6 lbs.=75%	2 lbs.=25%	0	8 lbs.	Clean Seed.
Row 5	Seed rolled in Sulphur Sulphur in hills	10 lbs.=65%	5.5 lbs.=35%	0	15 5 lbs.	Clean Seed.
Row 6	Corrosive Sublimate, ½ oz. to 3 galls.	14 lbs.=85%	2.5 lbs.=15%	0	16.5 lbs.	Clean Seed.
Row 7	Corrosive Sublimate, ½ oz. to 3 galls.	8 lbs.=70%	3.5 lbs.=30%	0	11.5 lbs.	Scabby Seed.
Row 8	Seed rolled in Sulphur Sulphur in hills	8 lbs.=64%	3.5 lbs.=28%	1 lb.= 8%	12.5 lbs.	Scabby Seed.
Row 9	Lysol, 1%	2.5 lbs.=31%	4 lbs.=50%	1.5 lbs.=19%	8 lbs.	Scabby Seed.
Row 10	Lysol, ½%	4.5 lbs.=50%	3 lbs.=33%	1.5 lbs.=17%	9 lbs.	Scabby Seed.
Row 11	Lysol, $\frac{1}{10}$%	6 lbs.=46%	5 lbs.=39%	2 lbs.=15%	13 lbs.	Scabby Seed.
Row 12	No treatment Check	3 lbs.=26%	6.5 lbs.=57%	2 lbs.=17%	11.5 lbs.	Scabby Seed.

Comparing the general results as obtained from the scabby and from the clean seed, it is seen that the scabby seed produced decidedly the smaller crop, the difference between the total yields being 16 pounds. This difference can only be explained on the supposition that seed-potatoes infested with scab not only endanger the crop as regards quality, but are less vigorous and consequently less productive than clean seed. A comparison between Rows 1 and 12 illustrates these facts regarding the inferior quantity and quality of tubers produced from scabby seed.

As regards the effect of the lysol solutions little need be added to the comments in this connection on experiment No. 1. Essen-

tially the same facts are revealed in both experiments. The 1% solution (Rows 4 & 9) has unmistakably diminished the yield, while the weaker solutions, though far better than nothing, are decidedly inferior in efficiency to corrosive sublimate (compare Rows 2 & 3 with Row 6, and Rows 10 & 11 with Row 7). It is quite possible however, that another factor in the use of lysol, disregarded in both of these experiments, may prove an important one. The duration of the treatment was the same in all cases 1½ hours, and it is quite possible that the 1% solution allowed to act for a shorter period might prove as effective in sterilizing the seed without at the same time diminishing its vitality. In view of the non-poisonous character of lysol and the convenience attending its use, it certainly seems worthy of further trial.

The use of sulphur as a preventive of potato-scab was recommended by Halsted.* According to one experiment conducted by him in 1895 on the College Farm, sulphur used at the rate of 300 pounds per acre (the seed being rolled in the sulphur and the remainder sprinkled in the rows) "kept off the scab almost completely, where the standard remedy, namely, corrosive sublimate, tested in four strengths, all failed absolutely to show any less scab than the check-belts" (almost 100%). The land used in this experiment is stated to have been in cabbages the year before, but no information is given as to the character of the soil with regard to the scab fungus. In another experiment, planned by Prof. Halsted, the land used was known to be thoroughly infested with scab, yet in this case the highest percentage of scab obtained in connection with corrosive sublimate (applied to the land at the rate of 120 pounds per acre) was only 5%, and this was reduced to 1% where the usual method of soaking the seed in a solution of the poison had been followed. On the other hand, with sulphur used upon the seed before planting, the crop showed 5% of scabby tubers, and this was reduced to 1% when the sulphur was applied to the land at the rate of 300 pounds and 150 pounds per acre. In this second experiment the stand was very seriously reduced where the corrosive sublimate was applied to the land, while sulphur applied in the same way at the rates above-mentioned gave a full stand. Inasmuch however, as corrosive sublimate applied in the usual way to the seed

* N. J. Agric. Exper. Sta., Rep. for 1895, pp. 270–275.

gave a full crop, the results would seem merely to indicate that soil applications of the sublimate are not to be recommended, but that when applied to the seed it is quite as efficient as sulphur applied to the land and more efficient than sulphur applied to the seed. Moreover it would be manifestly impracticable to use corrosive sublimate costing 10 cents per ounce, at the rate of even 30 pounds to the acre, when better results can be secured for the same area by the use of a few ounces dissolved in water. Sulphur is of course much cheaper, costing, by the barrel of 150 pounds, 2 cents per pound, or $3.00 per barrel, but even this is more expensive per acre than the corrosive sublimate solution as commonly used.

With the view of testing this matter sulphur was used in two rows of Experiment No. 2 at South Manchester, and the results compared with those obtained with corrosive sublimate. The seed for each row, after being washed, was rolled in one pound of sulphur (730 lbs. per acre), dropped in the row, and then the remainder of the sulphur was scattered in the open row. As already noted, the seed started quickly and grew well. The yield was practically the same as that from the check rows and from the rows treated with sublimate. Reference to the table on page 253 shows that for both the clean and the scabby seed the sublimate has the advantage of the sulphur as regards the quality of the crop, in the first case by 20%, and in the second by 6%. (Rows 5 & 6, 7 & 8.) Again the corrosive sublimate treatment proves superior, as a preventive of potato-scab, to any other material used. In the case of clean seed it reduced the amount of scab on the crop by 41%, in the case of scabby seed by 44%, and that, without any material diminution in the quantity of the crop. Considering both quantity and quality of the yield, it is superior to sulphur, its nearest rival, and is moreover cheaper on a large scale. The results obtained from that portion of the crop which was allowed to remain in the ground until Oct. 20th, and a comparison between those results and the condition of the crop a month earlier, are given in the following tables.

TABLE III. CORROSIVE SUBLIMATE, LYSOL, AND SULPHUR AS PREVENTIVES OF POTATO-SCAB ON INFESTED LAND. OCT. 20TH.

	Treatment.	1st Quality.	2d Quality.	3d Quality.	Total Yield.	
Row 1	0	7.5 lbs.=68%	3 lbs.=28%	0.5 lb.=4%	11 lbs.	Clean Seed.
Row 2	Lysol $\frac{1}{10}$%	8 lbs.=59%	4 lbs.=30%	1.5 lbs.=11%	13.5 lbs.	
Row 3	Lysol ½%	7.5 lbs.=71%	3 lbs.=29%	0	10.5 lbs.	
Row 4	Lysol 1%	7.5 lbs.=79%	2 lbs.=21%	0	9.5 lbs.	
Row 5	Sulphur	10.5 lbs.=75%	3.5 lbs.=25%	0	14 lbs.	
Row 6	Corrosive Sublimate	11.5 lbs.=78%	3 lbs.=20%	0.25 lb.=2%	14.75 lbs.	
Row 7	Corrosive Sublimate	10.5 lbs.=78%	3 lbs.=22%	0	13.5 lbs.	Scabby Seed.
Row 8	Sulphur	6 lbs.=55%	5 lbs.=45%	0	11 lbs.	
Row 9	Lysol 1%	5 lbs.=53%	4 lbs.=42%	0.5 lb.=5%	9.5 lbs.	
Row 10	Lysol ½%	6 lbs.=52%	5 lbs.=44%	0.5 lb.=4%	11.5 lbs.	
Row 11	Lysol $\frac{1}{10}$%	5 lbs.=40%	5 lbs =40%	2.5 lbs.=20%	12.5 lbs.	
Row 12	0	4.5 lbs.=46%	5 lbs =51%	0.25 lb.=3%	9.75 lbs.	

TABLE IV. COMPARATIVE RESULT OF LATE AND EARLY DIGGING ON THE QUALITY OF POTATOES EXPOSED TO SCAB.

Row.	Sept. 14. Total Scabby.	Oct. 20. Total Scabby.	Difference.	
1	56%	32%	−24%	
2	50%	41%	− 9%	
3	48%	29%	−19%	
4	25%	21%	− 4%	
5	35%	25%	−10%	
6	15%	22%	+ 7%	
7	30%	22%	− 8%	
8	36%	45%	+ 9%	
9	69%	47%	−22%	
10	50%	48%	− 2%	
11	51%	60%	+ 6%	
12	74%	54%	−02%	

These results are wholly unexpected and can not at present be explained. In only three cases do the figures show an increase of scab as a result of allowing the tubers to remain in the ground, and the increase is comparatively slight. On the other hand, the decrease in the amount of scab is very marked, especially in Rows 1 and 12, where the tubers were not protected by any fungicide whatever. Such facts could be explained only upon the supposition that the amount of scab-fungus in the soil, or its virulence, experienced a remarkable decrease and permitted the effects of earlier attacks to become in a measure obliterated. But such a supposition seems contrary to both reason and experience. Leaving then this question unsettled to await further elucidation, we may summarize the results of Experiment II as follows:

(1) Where the soil is infested with scab-fungus the crop of tubers will be seriously diseased if no preventive treatment is applied. The disease will be further aggravated under such conditions by the use of scabby seed. The use of infested land for potatoes should therefore be discountenanced.

(2) Lysol used in 1% solution injures the seed when the latter is allowed to remain one and a half hours in contact with it. Weaker solutions are almost inoperative when used upon either clean or scabby seed planted on infested land.

(3) Sulphur is an unsatisfactory preventive of potato-scab, no matter what the quality of the seed, when the soil is infested. It further tends to roughen the surface of tubers growing in contact with it.

(4) Of the three fungicides used, corrosive sublimate is the only one which can be recommended as a preventive of potato-scab. Its efficiency is diminished by the presence of the fungus in the soil.

(5) Infested land is to be avoided in planting potatoes. If its use is unavoidable, the selection of clean seed and treatment of the same with corrosive sublimate will enhance the value of the crop.

Experiment III.

The comparative effect of Fresh and Composted Manure in favoring the development of potato-scab, and the comparative value of Corrosive Sublimate, Lysol and Sulphur in preventing scab upon clean land.

This experiment was conducted at South Manchester upon a piece of land which had not recently borne potatoes and was presumably free from infection. In testing the effect of manure, clean seed was used without previous treatment in order to have only the one source of contagion. In testing the fungicides,

scabby seed was used in connection with commercial fertilizers, the contagion being thereby introduced on the tubers only.

The rows were arranged as follows, each row being 63 feet long:

Rows 1 and 2. Clean seed, fertilized with fresh barnyard manure.

Rows 3 and 4. Clean seed, fertilized with composted barnyard manure.

Row 5. Scabby seed, soaked for 1½ hours in $\frac{1}{10}$% lysol solution.

Row 6. Scabby seed, soaked for 1½ hours in ½% lysol solution.

Row 7. Scabby seed, soaked for 1½ hours in 1% lysol solution.

Row 8. Scabby seed, soaked for 1½ hours in corrosive sublimate solution (½ oz. to 3 galls.).

Row 9. Scabby seed, rolled in 1 lb. sulphur (230 lbs. per acre), remainder sprinkled in row.

Row 10. Scabby seed, no treatment. Check.

The manure was used liberally; one-half of it was first scattered in the open rows, the seed was then dropped upon it and pressed down, the rest of the manure was then scattered and the earth drawn over it. By this means direct contact was secured between the seed and the manure both above and beneath.

As in Experiment II, one-half of each row was dug Sept. 14th and the remainder Oct. 20th. The results of the first digging are presented in the following table:

TABLE V. EFFECT OF MANURE AND OF FUNGICIDES UPON THE PREVALENCE OF POTATO-SCAB ON CLEAN LAND. SEPT. 14TH.

Row.	Treatment.	1st Quality.	2d Quality.	3d Quality.	Total Yield.	
1 and 2	Fresh Manure No treatment	7 lbs.=27%	11 lbs.=42%	8 lbs.=31%	26 lbs.	Clean seed.
3 and 4	Composted Manure No treatment	14.5 lbs.=40%	14 lbs.=38%	8 lbs.=22%	36.5 lbs.	
5	Lysol, $\frac{1}{10}$%	8.5 lbs.=68%	3.5 lbs.=28%	0.5 lb.=4%	12.5 lbs.	Scabby seed
6	Lysol, ½%	9 lbs.=68%	4 lbs.=30%	0.25 lb.=2%	13.25 lbs.	
7	Lysol, 1%	6 lbs.=72%	2 lbs =25%	0.25 lb.=3%	8.25 lbs	
8	Corrosive Sublimate	13 lbs.=88%	1.5 lbs.=10%	0.25 lb.=2%	14.75 lbs.	
9	Sulphur	13 lbs.=81%	3 lbs.=19%	0	16 lbs.	
10	0 Check	7 lbs.=50%	5 lbs.=36%	2 lbs.=14%	14 lbs.	

Referring to this table, we will consider first the effect of the barn-yard manure. The results obtained in a similar experiment

last year showed that the use of composted manure, as compared with fresh manure, increased the amount of scabby potatoes by over 25 per cent. At the same time it was seen that the compost produced the larger yield. The former result was unexpected and the present experiment was therefore undertaken.

Comparing the results obtained from Rows 1 & 2 with those from Rows 3 & 4, we see at once that not only has the composted manure produced the larger yield, but the quality of the tubers grown on it is decidedly superior to that of the potatoes grown on the fresh manure. This seem to indicate that if barn-yard manure is to be used in connection with potatoes, it should be composted and thoroughly rotted before it is used. But that manure in any form does tend to induce scab upon potatoes, is abundantly proved by this experiment, the percentage of scabby potatoes from the manured rows being in excess of that obtained from the check row, even though the manured rows were planted with clean seed and the check row with scabby seed; nor is the yield much larger with the manure than with the fertilizer-chemical. We may conclude then, that it is inadvisable to use stable or yard-manure in any form for potatoes, even though neither the seed nor the soil present any source of contagion. This conclusion is based upon results uniformly obtained during three successive years and under many varying conditions.

The lysol treatment is again open to the same objections which we have considered in the other experiments. The weaker solutions are certainly better than nothing, as may be seen by comparing Rows 5 & 6 with Row 10, but the quality of the crop from both rows shows conclusively that the seed-potatoes, which were the only source of contagion, were not sterilized by the treatment. The 1% solution gives better results as regards the prevention of scab, but the yield has been very seriously diminished from its effects. The sulphur again proves superior to the lysol, and indeed shows a good record, (compare Rows 9 & 10.) But corrosive sublimate still heads the list as the best preventive of scab, all things considered. Its value is most decidedly marked when the seed offers the only source of contagion; and it is fortunate that such is the case, for the use of barn-yard manure is seldom unavoidable, and clean land can generally be substituted for land which has become infested with the scab-fungus; but it is frequently impossible to secure clean seed for planting, and under such circumstances the corrosive sublimate

treatment presents a cheap and expeditious method of securing at least an almost clean crop.

It only remains to consider again the effect, as regards the increase of scab, of leaving the potatoes in the ground.

The following tables show the results of the second digging, Oct. 20th, and a comparison between those results and the character of the crop a month earlier.

TABLE VI. EFFECT OF MANURE AND OF FUNGICIDES UPON THE PREVALENCE OF POTATO-SCAB ON CLEAN LAND. OCT. 20TH.

Row.	Treatment.	1st Quality.	2d Quality.	3d Quality.	Total Yield.
1 and 2	Fresh Manure.	9.5 lbs.=26%	13 lbs.=36%	14 lbs.=38%	36.5 lbs.
3 and 4	Composted Manure	15 lbs.=32%	18 lbs.=38%	14 lbs =30%	47 lbs.
5	Lysol, $\frac{1}{10}$%	12.5 lbs.=73%	4.5 lbs.=26%	0.25 lb.=1%+	17.25 lbs.
6	Lysol, ½%	13 lbs.=70%	5 lbs.=27%	0.5 lb.=3%—	18.5 lbs.
7	Lysol, 1%	13.5 lbs.=68%	6 lbs.=30%	0.5 lb.=2%+	20 lbs.
8	Corrosive Sublimate	14 lbs.=78%	4 lbs.=22%	0	18 lbs.
9	Sulphur	16 lbs.=77%	4.5 lbs.=22%	0.25 lb.=1%	20.75 lbs
10	0	10.5 lbs.=60%	6.5 lbs.=37%	0.5 lb.=3%—	17.5 lbs.

TABLE VII. COMPARATIVE EFFECT OF LATE AND EARLY DIGGING ON THE QUALITY OF POTATOES EXPOSED TO SCAB.

Row.	Sept. 14. Total Scabby.	Oct. 20. Total Scabby.	Difference.	
1 and 2	73%	74%	+ 1%	
3 and 4	60%	68%	+ 8%	
5	32%	27%	— 5%	
6	32%	30%	— 2%	
7	28%	32%	+ 4%	
8	12%	22%	+10%	
9	19%	23%	+ 4%	
10	50%	40%	—10%	

No satisfactory conclusions can be reached from these figures regarding the advisability or otherwise of leaving in the ground potatoes which are exposed to the attacks of the scab fungus. The manured rows dug Oct. 20th show an increase in the percentage of scab over those dug Sept. 14th, but the same is true of the rows which received the most effective treatment, while the row which had no treatment at all shows a decided decrease. These results do not even agree with those obtained in Experiment II, except as regards the decreased percentage of scab in the untreated rows.

Leaving this matter without further comment, we may summarize the results of Experiment III, as follows:

(1) Barn-yard manure as a fertilizer for potatoes, even when both soil and seed are free from the scab-fungus, will induce scab upon the crop and produce very serious injury. The use of manure should therefore be avoided.

(2) Lysol in a solution of 1% tends to reduce the yield, though it is fairly effective as a preventive of scab. The efficiency of weaker solutions of lysol is not such as to warrant their recommendation unless they are allowed to act for two hours at least.

(3) Sulphur as a preventive of potato-scab is second only to corrosive sublimate in efficiency. It costs more however, and is not so conveniently applied.

[One of the principal advantages claimed for sulphur in this connection is that when scattered in the hill or row it permeates the soil and serves to destroy the scab-fungus in the soil as well as upon the tubers, and can therefore be used to great advantage on scabby land. This cannot be properly claimed in the case of corrosive sublimate. If true, this character would add largely to the value of sulphur. Our experiments, however, fail to substantiate this claim conclusively, the percentage of scabby tubers upon infested soil being quite as much larger proportionately than that upon clean soil as in the case of corrosive sublimate. (Compare the results of Experiment II and Experiment III as regards the percentage of scabby tubers accompanying the use of sulphur and sublimate respectively.)]

General Summary.

A careful consideration of the results of the three experiments described in the preceding pages of this Report and of those

described in the Reports of this Station for the past two years, warrants the following conclusions regarding the treatment of potato-scab:

(1) Regarding the Soil. The surest means of infecting potatoes with scab is planting them upon land infested with the scab-fungus. No treatment as yet known will be of much avail against this source of contagion. In planting potatoes, beets or turnips therefore, select land which has not recently borne any one of these crops.

(2) Regarding the Fertilizer. Barn-yard manure is a fertile source of contagion against which no treatment is thoroughly effective. Avoid manure as a fertilizer for potatoes, beets or turnips, if possible.

(3) Regarding the Seed. Seed-potatoes carrying the living germs of the scab-fungus will produce a scabby crop, and, other things being equal, the amount of scab on the crop will be directly proportionate to the amount of scab on the seed. Select therefore, clean, smooth potatoes for planting, if possible. In case scab-spots are visible upon any of the seed-potatoes treat them all, before planting, with some well recognized fungicide.

(4) Regarding Preventive Treatment. (a) The cheapest and most effective method of preventing potato-scab consists in soaking the seed for one and one-half hours, before cutting or planting, in a solution of corrosive sublimate made in the proportion of 2¼ ounces to 15 gallons of water. This treatment reaches its highest efficiency in cases where the seed-potatoes constitute the only source of infection. It is efficient, though in a much lesser degree, in case barn-yard manure is used as a fertilizer, and is least effective in case the soil is infested.

(b) In certain cases flowers of sulphur applied to the seed before cutting and to the soil before planting reduces very materially the amount of scab upon the crop, but the expense and inconvenience of this treatment as compared with the more effective corrosive sublimate treatment, renders its adoption generally impracticable.

(c) Lysol can not as yet be recommended as a practicable preventive of potato-scab. It is possible that a ½% solution, allowed to act upon the seed for a period not less than two hours, would give satisfactory results. The non-poisonous character of lysol, the convenience attending its use, and its possible value as a fungicide render further experiments with it highly advisable.

(5) Use clean land and avoid manure. Plant only smooth seed, if possible. If there is a suspicion of scab in the soil or on the seed treat the latter thoroughly with corrosive sublimate solution.

(6) Lysol applied as a spray failed to give satisfaction as an insecticide or fungicide.

(7) The commercial article known as "Dry Bordeaux Mixture" proved distinctly inferior as a fungicide to Bordeaux mixture prepared in liquid form according to the recognized formula and applied as a spray.

ON THE SUSCEPTIBILITY OF VARIOUS ROOT-CROPS TO POTATO-SCAB AND THE POSSIBILITY OF PREVENTIVE TREATMENT.

BY WM. C. STURGIS.

It is already a well-known fact that beets and turnips planted on land infested with scab-fungus, from whatever source, are liable to the attacks of the fungus equally with potatoes. In order to carry this question further a preliminary investigation was undertaken this year at South Manchester, its object being to ascertain which of our common root-crops, besides beets and turnips, were susceptible to potato-scab, and if the attack of the fungus could be prevented or its virulence diminished by treatment of the soil with fungicides previous to sowing the seed. The land selected was a portion of the potato-field used last year, and was known to be thoroughly infested. The plants selected for the experiment were radishes (Long scarlet) parsnips, salsify, carrots (Long orange), turnips (Ruta-baga), turnips (White egg), beets (Mangels), and beets (Red Egyptian). The plot was carefully prepared and laid out in thirty-two rows (four to each variety of seed), each twenty feet long. Each set of four rows received the same treatment respectively, viz:

Row 1. Water, 2 gallons.
Row 2. ½% Lysol solution, 2 gallons.
Row 3. 1% Lysol solution, 2 gallons.
Row 4. Corrosive sublimate solution (1 ounce to 6 gallons), 2 gallons.

The rows were furrowed out, the solutions applied as evenly as possible from a watering-pot, and the seed sown. It was hoped that by this means the chemicals held in solution would permeate the soil about the seed, be washed down deeper by rains, and thus, in a measure at least, sterilize the soil occupied by the descending roots.

The planting was done May 15th and a careful record was kept during the early summer to ascertain the effect of the chemicals upon the germination of the seed and the growth of the plants. During this period the plants were thinned out twice. Later, as

the roots matured, ten or more were pulled from different parts of each of the rows which showed a sufficiently good stand. This was repeated at intervals of about three weeks until October 20th, the roots pulled being washed at once and carefully examined for traces of scab.

The germination of the seed and the growth of the plants was extremely irregular, owing to the effects of the chemicals. The check rows, which had been treated with water only, showed a good growth on June 5th, and gave a perfect stand in every instance. On the same date the rows treated with ½% lysol showed the seedlings above ground, with the exception of the mangels, carrots and parsnips, but the growth was scattered and uneven. Of the rows treated with 1% lysol, the beets and the salsify alone showed a few scattered seedlings; with corrosive sublimate the turnips of both kinds and the radishes had made a good start; the other rows so treated were still blank. It was evident therefore, that both of the chemicals used had injured the seedlings more or less; the injury was most apparent from the 1% lysol, less so from the sublimate, and least of all from the ½% lysol. None however, showed a satisfactory stand as compared with the check rows on June 5th.

On July 31st there were still many blank rows. With 1% lysol the beets and radishes showed a very incomplete stand, the carrots and salsify showed two or three plants each, the other seeds had failed altogether. With corrosive sublimate the radishes and both kinds of turnips showed a fair stand, but the plants were very backward, the beets showed a few scattered plants, the salsify showed two plants only, and the mangels, carrots and parsnips were a complete failure. With ½% lysol the parsnips and carrots alone failed completely, the beets and turnips showed a fair but much belated stand, the mangels, salsify and radishes showed only four or five plants each. We must conclude therefore, that lysol in a solution of ½% or more, and corrosive sublimate in the strength commonly used for disinfecting seed-potatoes, injure the seeds of our common root-crops so seriously when applied to the adjacent soil that their effectiveness in preventing scab upon the roots is a matter of no importance, except as a guide to future work upon the subject.

The susceptibility of the root-crops to scab was ascertained by successive examinations of a few roots pulled from each of the check-rows. The first examination was made July 31st. At this

time the beets, turnips and radishes alone were large enough to show tangible results. The radishes showed no sign whatever of scab; 28% of the turnips showed what might have been incipient scab-spots, but they were not sufficiently advanced to permit of accurate diagnosis; the beets were seriously diseased, 55% of the roots showing well-developed scab-spots over the greater part of their surface.

On August 18th samples were taken from the check-rows of the radishes, ruta-bagas, turnips, mangels and beets. The radishes again showed no scab and the experiment in their case was considered as closed. The ruta-bagas showed no scab, the turnips showed 17% of the roots slightly scabby, the mangels 40% and the beets showed no roots free from scab. On September 10th the beets showed 33% of scab, the turnips none, the ruta-bagas 43%, the carrots none and the parsnips none. The mangels were not examined on this date. On October 20th the parsnips showed 10% of the roots doubtfully scabby, the salsify showed all clean roots. No examination of the other root-crops was made on this date. This closed the experiment so far as the susceptibility to scab of the various root-crops was concerned.

It will be seen that of the eight varieties tested, the radishes and carrots alone remained unquestionably free from scab. The salsify showed very little if any scab, the parsnips gave similar results, the ruta-bagas gave an average of 21% of scab, the turnips 15%, the mangels 40% and the beets 63%.

Although, from the fact that the stand was so seriously affected by the chemicals used as preventives of scab, the results regarding their efficiency in this respect are of little practical value, it may be well to consider them briefly. The radishes, carrots, salsify and parsnips may be left out of the question since even when not treated they proved to be very slightly, if at all, susceptible to scab, and we need examine only the results obtained in the case of the beets, mangels, turnips and ruta-bagas.

On July 31st the turnips and the beets were examined, and on Aug. 18th and Sept. 10th all of the rows were examined with the exception of those in which the lack of plants, owing to the diminished stand, prevented further investigation. The following table represents the results obtained both as regards the stand on July 31st and the amount of scab present.

TABLE VIII. EFFECT OF FUNGICIDES APPLIED TO INFESTED SOIL IN PREVENTING POTATO-SCAB UPON ROOT CROPS.

			June 5.	July 31.		Aug. 18.	Sept. 10.	
	Row.	Treatment.	Stand.	Stand.	Scabby.	Scabby.	Scabby.	Average.
Beets	32	0	Good	Good	55%	100%	33%	63%
	31	Lysol ½%	Poor	Fair	40%	28%?	14%?	27%
	30	Lysol 1%	Very poor	Poor	25%	17%?	----	21%
	29	Cor. sub.	------	Very poor	Clean	----	25%	13%
Mangels	28	Cor. sub.	------	------	----	----	----	----
	27	Lysol 1%	------	------	----	----	----	----
	26	Lysol ½%	------	Very poor	----	----	17%	17%
	25	0	Good	Good	----	40%	----	40%
Turnips	24	0	Good	Good	28%?	17%	Clean	15%
	23	Lysol ½%	Poor	Fair	11%	----	Clean	6%
	22	Lysol 1%	------	------	----	----	----	----
	21	Cor. sub.	Fair	Fair	33%	----	Clean	16%
Ruta-bagas	20	Cor. sub.	Fair	Fair	----	----	17%	17%
	19	Lysol 1%	------	------	----	----	----	----
	18	Lysol ½%	Poor	Fair	----	----	40%	40%
	17	0	Good	Good	----	Clean	43%	21%

It is unnecessary to comment further upon these results; they may be summarized as follows:

(1) Beets, mangels, turnips and ruta-bagas are susceptible to potato-scab in a marked degree if planted in soil infested with the fungus causing that disease. None of these root-crops therefore, should occupy land which has recently borne scabby potatoes.

(2) Radishes, parsnips, salsify and carrots show little if any susceptibility to potato-scab when exposed to it in the soil.

(3) Corrosive sublimate in a solution of the strength commonly employed as a disinfectant for potatoes infested with scab, tends to diminish the yield from root-crops so seriously when applied to the adjacent soil, that its use in this way can not be recommended. The same is true regarding solutions of lysol of a concentration of ½% or more. The results of the experiment above tabulated seem to indicate that solutions of either corrosive sublimate or lysol, applied before seeding, to soil infested with potato-scab, will lessen very decidedly the amount of scab upon root-crops subject to this disease. It is questionable if these solutions, made of sufficient strength to insure partial immunity to the crop, will not so far decrease the yield as to render their use impracticable. The results indicate that further experiments in this direction are advisable.

ON A LEAF-BLIGHT OF MELONS.

By Wm. C. Sturgis.

Attention was called in our last Report, p. 186, to a serious disease of melons caused apparently by a fungus of the genus *Alternaria*. The disease attacked and practically ruined three large fields of melons owned by the Messrs. Meeker of Saugatuck. This year the owners were advised to make thorough applications of Bordeaux mixture, beginning just before the first flowers opened, and repeating the treatment three or four times at intervals of ten days. The melons were planted upon land which had not before been used for this purpose, and it was therefore hoped that the vines would be fully protected by the treatment. But late in July word was received from the Messrs. Meeker that the leaves of many of the vines were beginning to wilt and show other evidences of blight. Inspection of the vines showed a serious condition, but one differing decidedly in general appearance from that caused last year by the *Alternaria*. The spraying had been faithfully done and the vines were still covered with the mixture applied a few days previously for the third time, but the leaves were wilting and the edges turning yellowish in color. As the trouble advanced the portions first affected became brown and crisp, and sometimes the whole leaf was involved. The injury was further increased by the presence of great numbers of plant-lice which infested the lower side of the leaves and caused them to curl up, thereby preventing the thorough application of the Bordeaux mixture. Careful examination of the affected leaves showed only occasional indications of fungous-attack on the dead tissues. The portions of the leaves first affected were uniformly free from fungi, but it was observed that the texture of such leaves was abnormally thick and leathery, as though the tissues were surcharged with water. The weather had been such as to render this view highly probable. The wilting and yellowing of the leaves was first noticed as serious on July 23d. The weather for eight days previous to that date was characterized by long periods of cloudiness or haze sometimes followed by rain, alternating with short periods of clear, extremely hot sunshine. This condition was especially marked on July 18th and 19th. The melons occupied fairly level land having a southern exposure,

so that during rainy weather the soil retained a great deal of water and was supposably reduced in temperature. Moreover, when the sun shone the vines were exposed to its full force. It was further observed that the wilted and blighted leaves of water-melons showed numerous corky blisters upon the yellow areas, apparently caused by the rupture and subsequent healing-over of cells turgid with water. That under such meteorological conditions the leaves of certain plants will suffer serious injury is attested by many observers. A trouble almost identical with this melon-blight did great damage to tomato-plants grown under glass at this Station, and is commonly associated with a burning sun immediately following a prolonged period of cloudy weather. Lodeman (Cornell Agr. Exp. Sta., Bull. 76, p. 429) calls attention to a similar trouble affecting grapevines, and agrees in attributing it to "a disturbance of the equilibrium existing between the absorption of water by the roots and its evaporation from the leaves." Bailey and Galloway recognize the same cause and effect in the case of blighted tomatoes. It is unnecessary here to discuss the scientific explanation of this phenomenon. It is sufficient to note that in the case of the melons there is no other sufficient cause to which the trouble can be attributed. The two species of fungi found occasionally upon the dead leaf-tissue are, it is true, the agents of a distinct disease, but in this case no trace of them was found in the early stages of the blight, and very few traces at any time; the plant-lice undoubtedly worked much injury, but the majority of the leaves upon which they were most abundant were not blighted, while the blighted leaves harbored few lice; the meteorological conditions, on the other hand, were such as to cause injuries identical with those observed.

It is difficult to offer any suggestions as to the prevention of such injury; it would seem however, that by providing for thorough drainage during rainy weather and for screening the vines in case of a sudden access of sunshine, it might be in a measure avoided.

N. B. For a further discussion of the cause of this trouble as seen in the case of tomato-plants, see p. 232 of this Report.

ON THE PROBABLE WINTER–CONDITION OF THE FUNGUS OF PEACH–SCAB.

(*Cladosporium carpophilum.*)

By Wm. C. Sturgis.

Early in March I received some specimens of peach-twigs which showed evidences of a diseased condition. They were abundantly marked with more or less circular blotches of a yellowish-brown color with a dark gray or black border, somewhat resembling in appearance the familiar "bird's-eye rot" of grapes (*Sphaceloma ampelinum*, de Bary). Frequently these spots or blotches became confluent and invested the twigs so completely as to mask the normal pinkish-brown color of the young bark. Investigation showed that this trouble was widely spread. The original specimens were received from Milford, later it was found on peach-trees at Cheshire and on the Experiment Station grounds, and in the neighborhood of Bridgeport it occurred abundantly on peach, almond and apricot. Upon the apricot trees examined the blotches were of a pale gray color, and the growth of the fungus beneath the cuticle had ruptured the latter so that the surface of the blotches appeared marked with fine longitudinal cracks. In some cases a black fungous growth occupying the margin of the blotch, was observable with a hand-lens.

Microscopic examination of thin sections of both diseased and normal bark showed the same conditions prevailing as a result of the fungous growth upon all the host-plants above mentioned.

A section of a normal twig shows first the comparatively thick *cuticle* composed of a single layer of brownish cells, the superficial walls of which are much thickened and hyaline. Beneath this layer are four or five layers of very much flattened cells constituting, together with the cuticle, the *epidermis* or bark. In the peach the sub-cuticular layers of cells are much less developed than in the apricot and are sometimes wholly wanting. The *cambium* or delicate growing tissue immediately below the bark, is composed in both cases of large, thin-walled cells, the contents of which are colored pink in the more superficial layers (thus giving the characteristic color to the young twigs), and are abundantly provided with chlorophyl in the deeper layers. The cambium may measure 0.2^{mm} or more in thickness; in its deeper layers are

numbers of "cystoliths"—crystalline aggregations occupying intercellular cavities,—and beneath it are seen the groups of thick-walled wood-cells. So much for the microscopic structure of a normal twig of peach.

Sections through a diseased spot show a number of pathological changes. The cuticle has been partially broken down and separated from the layers of cells beneath; the latter have been increased in number by the transformation of the subjacent cambium cells into layers of flattened, corky cells, and the pink color of the upper layers of cambium cells has disappeared. By this transformation of the cambium cells the function of this layer is impaired, and if the injury becomes very deeply seated the cambium may become practically obliterated; this involves the death of the twig at that point. Occupying the spaces formed by the partial separation of the cuticle, is seen the *mycelium* or vegetative portion of a fungus, collected into aggregations of dark-brown spherical cells—a resting condition characteristic of the mycelium of many superficial or semi-superficial fungi. In many cases this mycelium has reached the surface through the cracks in the ruptured cuticle, and there are still to be seen the short, erect, brown *hyphae* upon which the spores of the former season were borne. What appear to be the spores themselves are occasionally seen, not attached to the *hyphae* or *sporophores*, but mingled with the fungous crust upon the surface of the bark. These spores are dark-brown, two-celled, and measure $15\mu-21\mu \times 5\mu-9\mu$, thus agreeing with those of the "peach-scab" fungus, *Cladosporium carpophilum*, Thüm.

At the time of this first examination the most careful search failed to show a single spore in direct connection with the mycelium; but on July 8th, twigs of peach showing the characteristic spots were collected at Milford, and the connection between the spores and the mycelium was evident. The edges of the spots were beset with a dense growth of erect fungous threads each bearing upon its tip a brown, two-celled spore identical with those seen earlier in the season.

Peach-scab is too well known to require any extended description. It attacks a number of stone-fruits such as the peach, nectarine, apricot, plum and cherry, producing small, round greenish-brown spots upon the fruit when not more than half grown. If the attack is severe the spots coalesce, the cells injured by the fungus repair the injury by the formation of cork, a hardening of

the tissues at that point results, they cease to expand and, as the surrounding portion of the fruit grows, the injured part cracks open, or the whole fruit becomes dwarfed and misshapen. The fungus causing this trouble has, until recently, been supposed to occur exclusively upon the fruit; Halsted however, has noted its occurrence on the leaves of the peach, where it produces a "shot-hole" injury.* He writes as follows: "The fungus prefers the portions of the leaf lying midway between the main veins, and as these portions become infested by the fungus the tissue dries up and finally falls away, leaving holes that are often circular in shape. The fungus upon the leaf agrees very closely with that upon the fruit, the chief difference, perhaps, being in the size of the spores, which are somewhat narrower as a rule than those upon the fruit."

We have therefore conclusive evidence that the fungus causing the scab of peaches and other stone-fruits, rendering them unsightly and diminishing their market-value, may do additional injury by attacking the leaves, and that it passes the winter in a sterile, resting condition on the twigs of the previous season's growth. With the advent of warm weather the fungus becomes active, and spores are produced abundantly which are carried by the wind or other agencies to the leaves and young fruit. Thus far the winter-condition has not been observed on other than peach, apricot and almond trees. The fact of its occurrence on the twigs suggests the advisability, in severe cases, of cutting away and burning the new wood in winter while the fungus upon it is dormant. In cases calling for less drastic treatment, great benefit would doubtless result from two thorough sprayings with a solution of 1 pound of copper sulphate in 25 gallons of water, applied early in the spring before the buds swell. If the previous crop of leaves or fruit has shown much scab, all the refuse should be gathered and burned before the copper sulphate solution is used. It can not be too strongly stated that when once the dormant stage of a parasitic fungus is known and located, preventive treatment is an easy matter as compared with the laborious operations necessary later, when the fungus is producing its myriads of spores, each a possible center of infection.

*N. J. Agr'l Exp't. Sta., Rep. for 1894, p. 329.

DESCRIPTION OF PLATE VII.

A leaf of tobacco affected with the leaf-spot disease, caused by the fungus *Cercospora Nicotianæ*. The circular spots where the tissues have been killed by the fungus are very evident; in places the diseased tissues have separated from the leaf, thereby causing ragged holes. Reduced ½.

PLATE VII. LEAF-SPOT OF TOBACCO.

ON A DESTRUCTIVE FUNGOUS DISEASE OF TOBACCO IN SOUTH CAROLINA.

Plate VII, and Plate VIII figs. 1–3.

By Wm. C. Sturgis.

On Aug. 7th, I received through the kindness of Prof. Halsted of the N. J. Agricultural Experiment Station a sample of tobacco leaf showing a remarkably diseased appearance, and it seems advisable to call the attention of tobacco-growers to the matter, because the disease is evidently capable of doing great damage to standing tobacco, and because its immediate cause is a fungus belonging to a very large genus having an almost unlimited range and liable therefore to occur north of the locality from which it is at present reported.

The diseased leaves were sent to Prof. Halsted from South Carolina, and when received at this Station early in August, were comparatively fresh and of a yellow color similar in tone to that of half-cured wrapper tobacco. The disease appeared as brown circular spots from the size of a pin-head up to half an inch or more in diameter, scattered thickly over the upper surface of the leaves. These brown spots are sometimes marked with whitish centers bordered by a darker, slightly raised line; and sometimes, especially towards the tips and edges of the leaves, they coalesce to form large brown blotches and areas of irregular outline. The leaf does not decay as a result of the spotting, but the whole leaf turns yellow prematurely and dies from the tip downwards, while the tissues immediately occupied by the fungus dry up and show a tendency to fall away, leaving irregular holes in the leaf (Plate VII). Microscopic examination of the diseased spots showed that they were uniformly invaded by a species of fungus belonging to the genus *Cercospora*, members of which cause leaf-diseases of the peach, violet, beet, celery and many other plants. The particular species under consideration was named by Messrs. Ellis & Everhart, *Cercospora Nicotianæ*, from the scientific name of the plant which it affects. The original description of the fungus is as follows.*

* Proc. Acad. Nat. Sci. of Phil., 1893, p. 170.

DESCRIPTION OF PLATE VIII.

Cercospora Nicotianæ, Ell. & Ev.

FIG. 1.—Cross-section of upper surface of tobacco-leaf showing the fungous threads bursting through in three places and producing spores on their tips. Magnified 95 diameters.

FIG. 2.—Portion of the same. Magnified 196 diameters.

FIG. 3.—Spores germinating after remaining thirty hours on the surface of a leaf floated in water. The germ-tubes are seen penetrating through two stomata, which alone are represented in the drawing. Magnified 375 diameters.

Puccinia Asparagi, DC.

FIG. 4.—Two sori of summer-spores occupying the external tissues of an asparagus-stem. Magnified 50 diameters.

FIG. 5.—Portion of the same. Magnified 196 diameters.

FIG. 6.—Portion of a sorus of winter-spores. Magnified 196 diameters.

FIG. 7.—A sorus of winter-spores. Magnified 50 diameters.

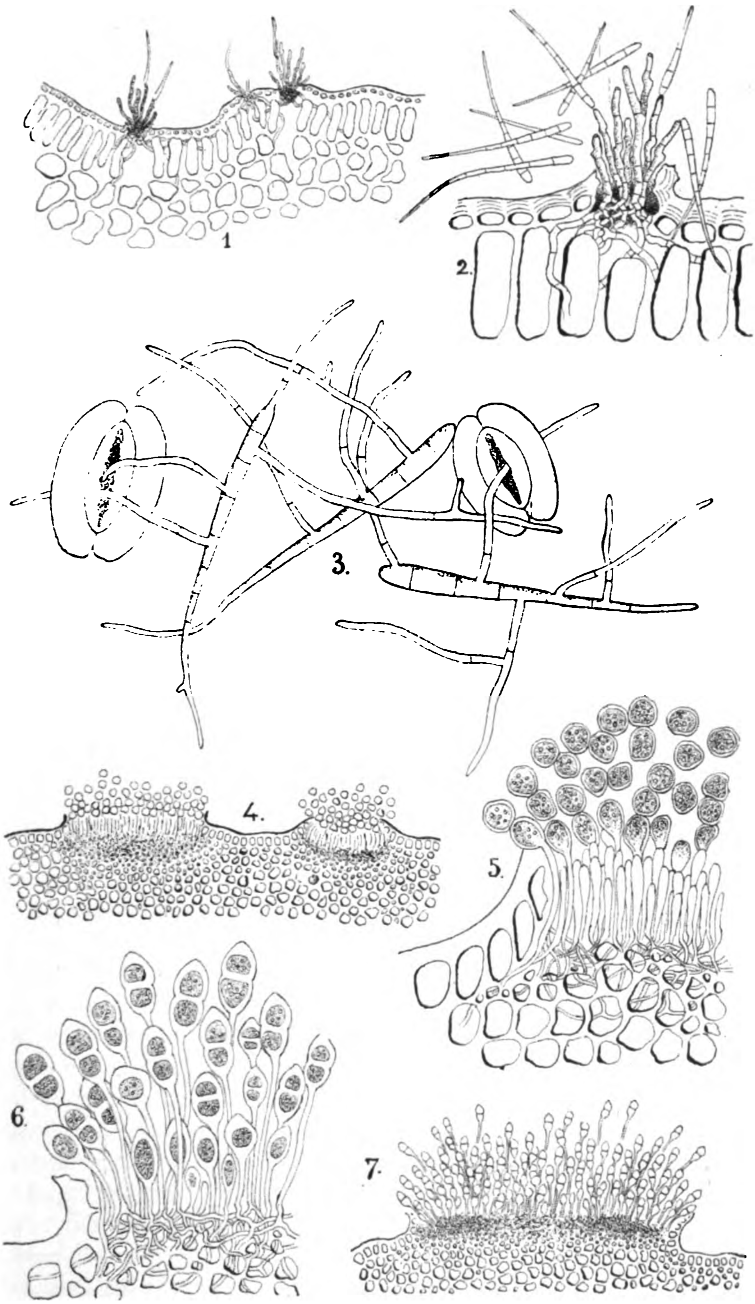


PLATE VIII. LEAF-SPOT OF TOBACCO AND RUST OF ASPARAGUS.

"*Cercospora Nicotianæ, E. & E. On leaves of tobacco, Raleigh, N. C. Oct., 1891. Spots amphigenous, pale, becoming white,* 2–5^{mm} *diam., with a narrow, inconspicuous, reddish, slightly raised border, often concave below. Hyphae tufted, amphigenous,* $75–100 \times 4–5\mu$, 2–3-*times geniculate above and sometimes with a short lateral branch, brown, septate. Conidia slender,* $40–75 \times 3–3\frac{1}{2}\mu$, *hyaline, slightly curved, multiseptate (mostly about* 6-*septate*)."

The general appearance of the specimens examined by me and the slightly larger size of the spores indicate that the fungus was more luxuriant and more perfectly developed than in the case of the specimens which served as a basis for the original description; otherwise the agreement is exact. The fruiting threads of the fungus are found usually near the centers of the diseased spots on both surfaces of the leaf. They arise from the delicate vegetative threads which permeate the leaf-tissues in all directions, and as a rule they issue in tufts through the "breathing-pores" or *stomata* of the leaf, each thread or *sporophore* bearing upon its tip a long, tapering spore divided by cross-partitions into a number of cells. (Plate VIII, figs. 1 and 2.) The spores germinate readily, and when bits of the infested leaves are floated upon water in a watch-glass for 24–48 hours the microscope shows the spores producing germ-tubes which grow over the surface of the leaf, gain entrance through the *stomata*, and spread rapidly within the tissues of the leaf. (Plate VIII, fig. 3.)

The trouble seemed to be so serious that, at Prof. Halsted's suggestion, I entered into correspondence with Mr. J. R. Barron, of Workman, S. C., from whom the diseased leaves came. This correspondence elicited the following facts regarding the prevalence and the serious character of the disease in the South. Mr. Barron states that, while it is new in his immediate neighborhood, it has long been known in North Carolina. The present season seems to have been peculiarly favorable to its spread; it caused a loss of $1,000 on Mr. Barron's crop, in fact the crop throughout his section of the country was practically ruined by it and at last accounts it was spreading. It attacks at least four different varieties of tobacco grown on various soils, loamy, clayey and upland. There seems to be no definite period at which the plant first becomes subject to the disease, the latter sometimes appearing by the time the young plants show six leaves, sometimes not until later, but the period of worst attack seems to be just as the

tobacco is ripening. Mr. Barron writes that the weather in his neighborhood was very dry up to June 20th, but moderately damp from that time until harvest, a fact which, taken in connection with the late appearance of the trouble, would indicate that the latter thrives best in damp weather. In the localities where the disease occurs it is commonly known as "frog-eye," but this term seems to include at least two distinct conditions of the tobacco-leaf. In the Tenth Census of the United States (1880), Vol. III, p. 856, occurs the following note upon "Frog-eye" or "White-speck:" "This disease, if it is such, is of rare occurrence, and is little understood. In Florida, white specks are a sure indication of fine texture in the leaf, and this 'frog-eye' appearance was at one time much esteemed. This particular marking seems to result from conditions of soil or climate, or from both, and some varieties are more frequently affected than others." This seems to be a different thing from the trouble caused by the Cercospora, though known by the same name. Under the name of "small-pox" (*Pockenkrankheit*), several European observers describe a disease of tobacco common abroad and evidently very similar in appearance to our "frog-eye," but all agree in attributing it to a deficient supply of water occasioned either by an imperfect development of the root-system or by a lack of moisture in the soil.

A third disease, somewhat similar in character, is known among tobacco-growers in Virginia as "spot" or "firing," and is attributed to sudden changes from very wet to very dry weather, or *vice versa*. This trouble, however, seems to be sufficiently distinct from the "frog-eye" to be disregarded in this connection.

Finally, Ellis & Everhart described in 1892 a fungus occurring upon tobacco in North Carolina, which they named *Macrosporium tabacinum*. After describing it they say, "This is the 'White-speck' of the North Carolina planters." The fungus *Macrosporium* is certainly as distinct as possible from *Cercospora*, and upon the very many leaves which I examined, and which were abundantly spotted with the latter fungus, I found no trace of the former.

We have, therefore, (1) the "frog-eye" or "white-speck" of the Census Report; (2) the "small-pox" of European observers; (3) the "white-speck" of the North Carolina planters, due to a *Macrosporium;* and (4) the "frog-eye" of North and South Carolina, uniformly associated with a species of *Cercospora*. It seems probable that the primary cause of the trouble mentioned

in the Census Report was overlooked, and that the "frog-eye" and the "white-speck" of the southern States are very similar diseases caused by two distinct species of fungi, but often confounded by the casual observer. The European trouble is probably different, as it seems impossible that a fungus so apparent as either of those above mentioned could have been overlooked by careful observers.

The problem of finding a preventive for a fungous disease which attacks the leaves of tobacco in the field is an extremely difficult one. Bordeaux mixture would doubtless check the "frog-eye," but its use would be very questionable, owing to the gummy texture of the tobacco-leaf and the use to which the leaf is put. Possibly by beginning the treatment soon after the plants are set and discontinuing it at least a month before cutting, the disease would be prevented and at the same time the ripening leaves be freed by subsequent rains from all traces of the fungicide. This result would be more certainly attained by the use of the ammonia solution of copper-carbonate, a powerful fungicide which the texture of the leaf would cause to adhere sufficiently well, but which would wash off more readily and completely than Bordeaux mixture.

A third fungicide of possible value in this connection is flowers of sulphur dusted upon the leaves. This would undoubtedly adhere well, and would be much more convenient to apply than any liquid fungicide inasmuch as, in the case of tobacco, any fungicide would have to be applied by hand. Used liberally in clear, sunny weather, sulphur has a very marked fungicidal value.

Finally, it is quite possible that judicious fertilizing might so far increase the vigor of the plants as to render them less subject to, if not exempt from fungous disease.

There is good evidence to show that, in the case of peach trees, the application of a soluble nitrogenous plant-food, such as nitrate of soda, serves to increase the general vigor of the trees and thus prevent the attacks of the shot-hole fungus (*Cercospora Persica*), a disease very similar to the "frog-eye" of tobacco. With this idea in mind, a sample of the fertilizer chemical used by Mr. Barron was secured and was submitted to Mr. Winton, of this Station, for analysis, with the following result :

Total Nitrogen	2.16%
Total Phosphoric Acid	12.32%
Total Potash (as Muriate)	1.09%
Chlorine	1.05%

These figures indicate a rather low-grade quality of fertilizer with a marked deficiency of potash, but whether this fact is sufficient in itself to account for the susceptibility of the tobacco to fungous attack remains to be proved. Mr. Barron was advised to experiment in this direction by increasing the percentage of potash, using for this purpose either the sulphate, or else cotton-hull ashes, and to compare the results so obtained with those obtained on an adjoining plot fertilized with the low-grade fertilizer analyzed by us. Until more definite information is obtained on this point some advantage would doubtless result from careful attention to drainage, in case the soil is inclined to be soggy, and the burning of all refuse from a diseased crop.

Meanwhile, it would be well for Connecticut tobacco-growers to be on the watch for this leaf-disease and to report it immediately upon its appearance, in order that preventive measures may be instituted without delay.

NOTES ON THE SO-CALLED "SHELLING" OF GRAPES.

By Wm. C. Sturgis.

Although the condition of grapes known as "shelling" has been carefully investigated and its probable cause assigned,* the trouble has been reported once in this State and it therefore seems advisable to comment briefly upon its character, cause and possible prevention.

The single case reported occurred during the past summer at Cheshire on a row of Niagara grapes, and was first noticed about Aug. 20th. The characteristics of the disease are very evident in the fruit. Shelling grapes, at least in the case of green varieties, show a peculiar though indistinct mottling of the surface; the skin is abnormally thick and the whole berry therefore feels harder than healthy berries at the same stage of development; a section of a diseased berry shows a narrow brown zone just beneath the skin; the taste of shelling grapes is noticeably insipid as compared with the tart, astringent flavor of the unripe but healthy fruit; finally, the woody tissues of the stem which enter the fruit and, in the case of sound berries, remain attached to the stem when the berry is pulled off, are so far weakened in

* Lodeman in Cornell Univ. Agr. Exp. Sta., Bull. 76, pp. 413–440, Nov., 1894.

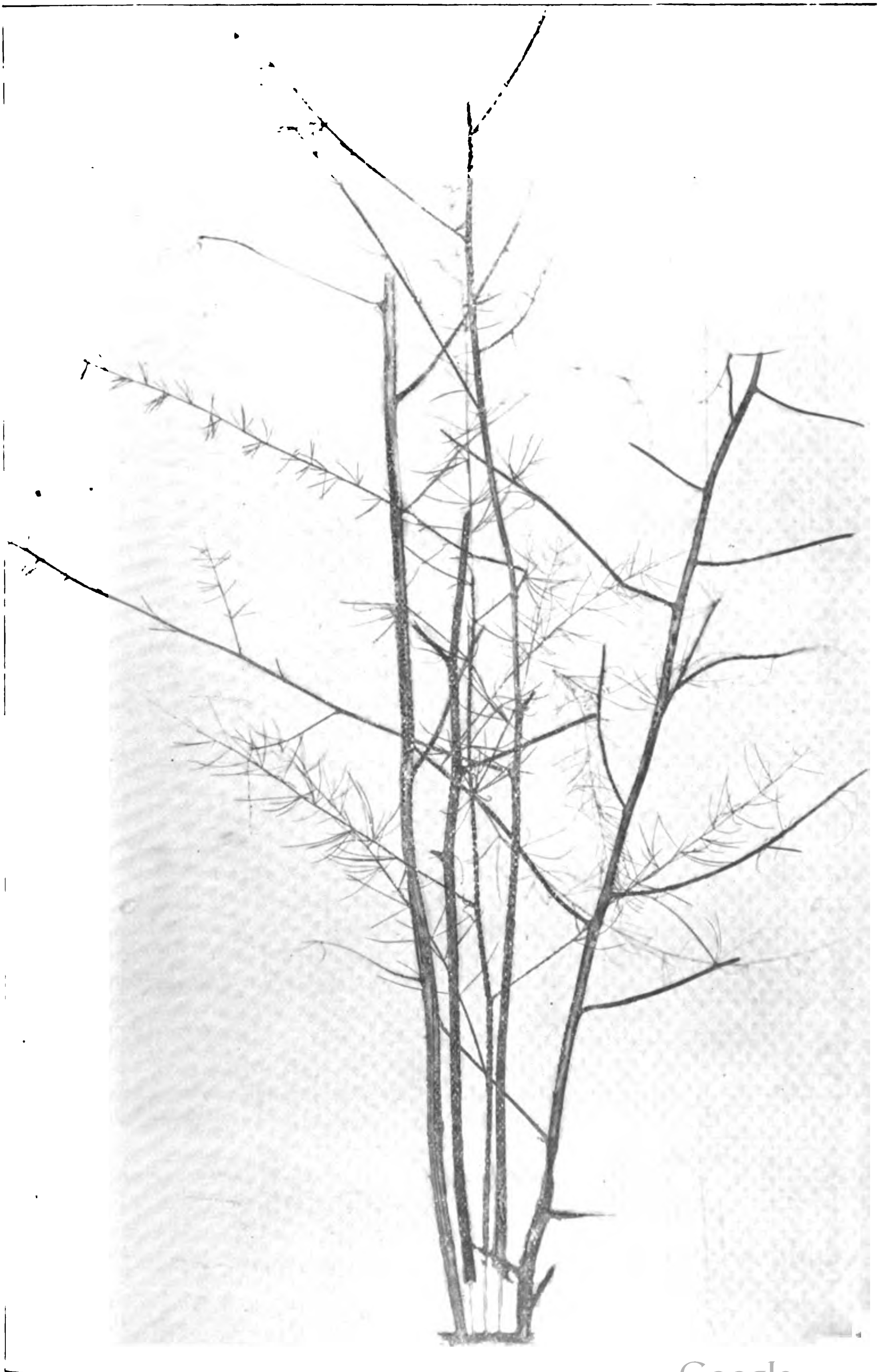
the case of shelling grapes that the weight of the berry is sufficient to cause them to separate from the stem, and the berries fall to the ground, leaving the end of the stem perfectly even, "as if cut with a knife." This dropping of the fruit from two to three weeks before maturing is a characteristic symptom of shelling, and may result in very serious loss, a loss emphasized by the fact that the trouble does not confine itself to certain bunches on a vine leaving others unaffected, but affects portions, generally the end, of every bunch.

After a most exhaustive consideration of all the possible causes of shelling, Lodeman concludes (l. c., p. 452) that neither insects nor fungi are to be considered as a primary cause of the trouble; that the condition of the soil, apart from the supply of available plant-food, does not exercise any marked influence on the degree of shelling; that meteorological conditions are not primarily responsible for it; and that it is not due to a lack of phosphoric acid. Among the agencies which may increase or favor the diseased condition, Lodeman mentions parasitic fungi, which weaken the function of the leaves; a weakening of the plant due to overbearing; the drawing of nourishment from the fruit by the overproduction of wood; an excessive supply of nitrogen emphasized by too much tillage; prolonged drought or excessive rains following drought; and a poorly developed root-system resulting in a general weakening of the plant. The condition of the food-supply as regards potash seems to be the only remaining factor to be considered, and Lodeman is inclined to attribute the primary cause of shelling to a lack of that element. This view is in a measure substantiated by observation and experiment.

The conditions under which shelling occurred at Cheshire are in line with Lodeman's conclusions. The vines have occupied for nine years a piece of land formerly used for a nursery; the soil is light, well-drained and naturally dry; the only fertilizer which has been applied has been occasional odds and ends, such as waste mortar, cellar sweepings, etc. Under these conditions one would suspect a lack of potash in the soil. The general condition of the vines was poor. The leafage was not over-abundant and was badly affected with downy mildew; the crop was fair, apart from the shelling, but fully half the fruit had dropped from the latter cause. There had been abundance of rain throughout the season, a horse-cultivator had been used two or three times, but no work had been done with the hoe and the ground was decidedly weedy.

DESCRIPTION OF PLATE IX.

Stems of Asparagus affected with "Rust," caused by the fungus *Puccinia Asparagi*, DC. The black sori are seen occupying lines and patches on the stems. Slightly reduced.



The bunches of grapes hung, as a rule, straight down from the bunch so that the flow of sap was not obstructed.

In view of all the circumstances, it seemed fair to assume that the shelling in this case was due to a deficiency of potash in the soil, emphasized by a weakened condition of the vines occasioned by poor culture and the presence of mildew upon the leaves. With a view of obtaining further light upon the matter another season, the owner was asked to divide this row of Niagara grapes into four equal portions, and in the spring to apply kainit to the first portion, muriate of potash to the second, an excess of nitrogen to the third, and to leave the fourth without additional fertilizing as a check.

MISCELLANEOUS NOTES ON FUNGOUS AND INSECT PESTS.

By Wm. C. Sturgis.

Treatment for Leaf-curl of Plum.—In my last report I called attention to a serious disease of Japanese plums caused by the leaf-curl fungus, *Exoascus mirabilis*, Atk. During the past summer the affected trees received thorough treatment with Bordeaux mixture, with the result that they were completely protected and no trace of leaf-curl was apparent. The foilage remained healthy throughout the season, but owing to the injury done last year the crop was a failure.

Rust of Asparagus.—(Plate VIII, figs. 4–7 and Plate IX.) Late in the summer of the present year Prof. Halsted discovered a very serious outbreak of this disease in New Jersey, and consequent investigation showed that it was widely spread throughout New England and adjacent states. It is caused by the fungus *Puccinia Asparagi*, DC, and makes its appearance in August or September upon the stalks and branches of the asparagus bushes. The fungus saps the vitality of the plants so that an infested patch appears as if blighted by drought, a sickly yellowish color replacing the normal green. Unfortunately this is one of those diseases which are easily overlooked; on the grounds of this Station, where it proved to be very abundant, it was not observed until Prof. Halsted's circular led to a close examination of the plants.

The fungus is easily recognized upon close inspection. It presents the appearance of small rust-colored or black pustules, technically called *sori*, arranged in lines or scattered groups upon the stem and branches of the affected plant. (Plate IX.) Microscopic examination shows that these *sori* have their origin within the tissues of the plant, and later rupture the epidermis, producing innumerable spores freely exposed to the air (Plate VIII, figs. 4–7). These spores are of two kinds, first, a form, almost spherical and one-celled, which may be called the summer-spores; these appear first and impart their color to the pale or rusty-brown *sori* (Plate VIII, figs. 4 & 5). The second form appears later; they are almost black in color, borne on long stalks, provided with thick walls, and divided in the middle by a cross-partition. (Plate VIII, figs. 6 & 7.) These we may call the winter-spores, since it is they which live through the winter upon the refuse of the diseased bushes and serve to propagate the disease with the return of warm weather in the spring. There can be no question but that this fungus bids fair to become a serious pest, and the only practical method of keeping it in check at present consists in burning every vestige of the diseased bushes. It is barely possible that some fungicidal treatment may prove available, but the rust-fungi are usually very resistant to fungicides, and thorough burning in the autumn or late summer will be more than likely to make unnecessary a resort to fungicides the following season.

The Spread of the San José Scale in Connecticut.—In the Report of this Station for 1895, p. 192, attention was called to the recent appearance of this dreaded scale-insect in the neighborhood of New London, Hartford and Bridgeport. At that time we sent out circulars to ninety-two fruit growers, all of whom had purchased trees from a New Jersey nursery known to have been infested with the scale. We have received forty-three replies to these circulars, of which thirteen report the presence of the scale, twenty-eight are negative and two doubtful. The centers of infection at present are along the coast at Darien, Bridgeport, New Haven, New London, Groton and Mystic; and in Hartford County at Hartford, Farmington, New Britain and Plantsville. Taking the forty-three replies received to our circular as a basis for estimate, it seems fair to conclude that the scale is very widely spread throughout the fruit-growing portions of the State. With regard to remedial measures nothing can be

added at present to the recommendations published in Bulletin 121 of this Station and included in our Annual Report for 1895, pp. 194–202.

A word of warning, however, should be said regarding the use of a substance known as "Dendrolene." This material was originally prepared in New Brunswick, N. J., and was highly recommended as a means of preventing the attacks of borers, cankerworms, plant-lice, the pear psylla, codling moths and scales, with no injury to the trees, except when applied to young twigs or in such a manner as to cover the buds. Later we received from the Bowker Fertilizer Co., of Boston, a can of dendrolene, with the request that we give it a trial. At this time we were preparing to treat the orchard of Mr. J. L. Raub, of New London, which was completely infested with the San José scale, as well as with the bark-beetle, *Scolytus rugulosus*. Early in April the trees infested with scale were treated with a solution of whale-oil soap in the proportion of 1 lb. to 5 galls. No injury resulted from this treatment, and specimens of bark sent us by Mr. Raub on April 16th showed only about 20 per cent. of living scales. On April 23rd the dendrolene was sent to Mr. Raub with directions as to its use. It was to be applied in a thin coating with a paint-brush to the trunk and limbs of two infested peach trees; two neighboring trees, equally infested, were to receive a coat of whitewash; two others a solution of caustic potash, and the remainder of the infested trees were to be treated with kerosene emulsion. All of the peach trees infested with the bark-beetle were to be treated with dendrolene. Through a misunderstanding the dendrolene was used much more generally throughout the orchard than we had intended, but the quantity originally sent was small, so that each tree received only a thin coating upon the trunk and the base of the branches. Under date of June 4th word was received from Mr. Raub that all of the trees treated with dendrolene were dying. I at once visited the orchard and examined the trees. I found the bark beneath the dendrolene in bad condition, but at the time I attributed that condition to the effect of the scale, and expected, now that the latter were dead, that the bark would recover. It seemed best, however, to advise a cessation of further treatment. Early in November Mr. Raub wrote that the trees had not recovered, and the cause of death was evident upon examination of specimens of bark sent at the same time. The dendrolene upon them was still slightly sticky; it had penetrated the

outer bark and had reduced the cambium to a brown, damp powder. It seems advisable to record the disastrous effect following the use of dendrolene in this instance, since the article has been widely advertised on the basis of a most careful and, on the whole, successful trial in New Jersey, but has since been found by Profs. Troop, of the Indiana Experiment Station, and Goff, of the Wisconsin Station, to produce results identical with those above reported.

The only plausible explanation of these facts is, that the substance at present sold as dendrolene is of a different composition from that originally made and named by Prof. Nason, of New Brunswick, N. J. This explanation is borne out by the fact that the successful experiments in New Jersey upon which the value of dendrolene is based were all made with the article as prepared by Professor Nason, while the complaints regarding it have all emanated from those who have used the article as prepared and sold by the Bowker Fertilizer Co. Fruit-growers are therefore warned that the use of dendrolene, as at present prepared, is attended with great danger to the trees to which it is applied, and that, at best, it is unsafe to make free use of dendrolene until some means is found of lessening its penetrating power.

EXPERIMENTS IN GROWING TOBACCO WITH DIFFERENT FERTILIZERS.

FINAL REPORT ON THE FERMENTED CROPS OF 1895.

By E. H. Jenkins.

The object of these experiments is to study the effects on the quality of wrapper-leaf tobacco of certain fertilizers commonly used by our Connecticut growers. Each plot under experiment receives the same fertilizers for a term of years in order to test these fertilizers under the varying climatic conditions which a succession of years affords, and final judgment on the quality of the crops is made after they have been fermented in the case and are ready for manufacture.

The work was begun in 1892 and has been carried on each year since then by this Station, in connection with the Connecticut Tobacco Experiment Company.

A full description of this experiment will be found in former reports of this Station, viz.: 1892, pp. 1–24; 1893, pp. 112–144; 1894, pp. 254–284; 1895, pp. 128–156.

An account of the growing, harvesting and curing of the crop of 1895 is printed on pages 146 to 156 of the 19th Annual Report of this Station for 1895.

Samples of the long and short wrappers from each plot, with top leaves and seconds sufficient to fill the case, were cased down for fermentation at the warehouse of Mr. L. B. Haas in Hartford, on Dec. 14th, 1895. The case lay undisturbed till Nov. 23d, 1896, when it was opened and the samples examined.

Shrinkage during Fermentation.

The tobacco weighed 337 pounds when it was cased. After fermentation it weighed 301 pounds, having lost in the intervening time 36 pounds, or 10.7 per cent.

This loss is less than has been previously observed in our experiments. The percentage losses each year have been, crop of 1892, 13.8 per cent.; of 1893, 14.0; of 1894, 11.1, and of 1895, 10.7 per cent.

The fermented crop of 1893 was judged by the expert to be "unsweated," while the others were called "well sweated," and

particularly this crop of 1895, which had lost less weight by fermentation than any of the others.

It is the *nature* of the change during fermentation—about which almost nothing is known at present—and not the total loss by fermentation, which determines the effect of the process on the quality of the leaf.

JUDGMENT OF THE EXPERT.

Each lot of tobacco was marked with a number, different from the one used in the previous year, and which gave no indication of the plot from which the tobacco came.

The lots were examined and graded by Mr. Benjamin L. Haas of Hartford, who has done the same work each year since beginning the experiment. Mr. Haas devoted two days to the work, and there has thus been secured a perfectly unbiased and intelligent judgment by an expert fully acquainted with the present requirements of the trade.

A strict judgment has been given, noting all defects in the leaf.

The crops on the experiment field were in general of quite as good quality as those grown elsewhere in the neighborhood.

General Remarks.—All the samples of tobacco from the experiment field were ripe and sound.

In general all the samples show a great improvement in burn over those of previous crops. The short, light wrappers on all the plots are nearer what the trade wants in tobacco than anything we have produced hitherto, not excepting the crop of 1892.

There are few lots of really poor tobacco, and some of the lots have been graded down simply on account of their color. While most of the tobacco crops of 1895, examined by Mr. Haas, have showed some white vein after fermentation, the tobacco from the experiment field has scarcely a trace of it.

Some of the lots have a white deposit on the stem and veins, extending occasionally to other parts of the leaf surface.

This is usually called in the trade "white mold," a name which covers two very distinct things. One is a fungus, firmly attached to the tissues, the other is a crystalline salt of magnesia, probably the malate, which is easily brushed off from the affected leaves. Both damage the leaf for sale, though the latter disappears entirely in the process of manufacture and does not damage either the taste or burning quality of the leaf. The former is not

so readily gotten rid of and may possibly be the cause of the mustiness which develops during fermentation and ruins the quality of the leaf.

The lots of tobacco which showed any traces of those two kinds of "white mold" were lots H, K, M, O, AA, on which there was a very small amount of the genuine mold, and lots E, G, H, K, M, N, O, R, S, X, Z, on which there was the white crystalline salt.

In every case the amount found was very small, not enough to seriously damage the selling quality.

Following are the details of the expert's judgment of the separate crops:

LOT A.

Fertilizers: 1579 lbs. cottonseed meal and 1297 lbs. cotton hull ashes per acre, containing 105 lbs. nitrogen, 159 lbs. phosphoric acid and 340 lbs. potash. Cost, $46.55 per ton.

Yield: 830 lbs. long wrappers per acre.
220 " short " " "

Total 1050 "

Quality:—*Burn*, holds fire well, coals very slightly. *Ash*, clear gray, hard. *Colors*, medium mottled. *Texture*, well sweated, open grain, fair finish. *Yield*, fairly profitable. *Size*, undesirable. *Vein*, fine. *Stem*, small. *Relative rank*, 14th.

LOT B.

Fertilizers: 1669 lbs linseed meal and 1324 lbs. cotton hull ashes per acre, containing 105 lbs. nitrogen, 152 lbs. phosphoric acid and 340 lbs. potash. Cost, $52.32.

Yield: 780 lbs. long wrappers per acre.
240 " short " " "

Total 1020 "

Quality: *Burn*, holds fire well, coals very slightly. *Ash*, clear gray, hard. *Colors*, dark mottled. *Texture*, well sweated, open grain, dull finish. *Yield*, fairly profitable. *Size*, very desirable. *Vein*, light. *Stem*, medium. *Relative rank*, 10th.

LOT C.

Fertilizers: 2631 lbs. cottonseed meal and 1221 lbs. cotton hull ashes per acre, containing 175 lbs. nitrogen, 177 lbs. phosphoric acid and 340 lbs. potash. Cost, $56.41 per acre.

Yield: 950 lbs. long wrappers per acre.
330 " short " " "

Total 1280 "

Quality:—*Burn*, good, holds fire fairly. *Ash*, clear white, hard. *Colors*, dark. *Texture*, well sweated, open grain, dull finish. *Yield*, unprofitable. *Size*, undesirable. *Vein*, prominent. *Stem*, medium. *Relative rank*, 25th.

LOT D.

Fertilizers: 3158 lbs cottonseed meal and 1184 lbs. cotton hull ashes per acre, containing 210 lbs. nitrogen, 186 lbs. phosphoric acid and 340 lbs. potash. Cost, $61.38 per acre.

Yield: 1170 lbs. long wrappers per acre.
300 " short " " "

Total 1470 "

Quality:—*Burn*, holds fire well. *Ash*, mixed gray, hard, *Colors*, dark. *Texture*, good open grain, well sweated, dull finish. *Yield*, fairly profitable. *Size*, medium to large. *Vein*, fine. *Stem*, light. *Relative rank*, 9th.

LOT E.

Fertilizers: 2083 lbs. castor pomace, 1254 lbs. cotton hull ashes per acre, containing 105 lbs nitrogen, 205 lbs. phosphoric acid and 340 lbs. of potash. Cost, $43.83 per acre.

Yield: 1010 lbs. long wrappers per acre.
300 " short " " "

Total 1310 "

Quality:—*Burn*, holds fire. *Ash*, mixed gray, hard. *Colors*, medium mottled, dark. *Texture*, well sweated, open grain, dull finish. *Yield*, unprofitable. *Size*, undesirable. *Vein*, curly. *Stem*, heavy. *Relative rank*, 22d.

LOT F.

Fertilizers: 1669 lbs. linseed meal, 536 lbs. cotton hull ashes and 277 lbs. Cooper's bone per acre, containing 105 lbs. nitrogen, 152 lbs. phosphoric acid and 150 lbs. of potash. Cost, $38.47 per acre.

Yield: 640 lbs. long wrappers per acre.
220 " short " " "

Total 860 "

Quality: *Burn*, holds fire well, coals very slightly. *Ash*, clear gray, hard. *Colors*, dark mottled. *Texture*, well sweated, medium open grain, dull finish. *Yield*, fairly profitable. *Size*, medium to large. *Vein*, light. *Stem*, medium. *Relative rank*, 16th.

Lot G.

Fertilizers: 3472 lbs. castor pomace and 1149 lbs. cotton hull ashes per acre, containing 175 lbs. nitrogen, 253 lbs. phosphoric acid and 340 lbs. of potash per acre. Cost, $51.87 per acre.

Yield: 850 lbs. long wrappers per acre.
290 " short " " "
Total 1140 "

Quality:—*Burn*, coals slightly, holds fire. *Ash*, clear gray, inclined to flake. *Colors*, medium to dark. *Texture*, well sweated, open grain, dull finish. *Yield*, unprofitable. *Size*, medium to large. *Vein*, medium to large. *Stem*, medium. *Relative rank*, 28th.

Lot H.

Fertilizers: 4166 lbs. castor pomace and 1097 lbs. of cotton hull ashes per acre, containing 210 lbs. nitrogen, 277 lbs. phosphoric acid and 340 lbs. of potash per acre. Cost, $55.93 per acre.

Yield: 1190 lbs. long wrappers per acre.
260 " short " " "
Total, 1450 "

Quality:—*Burn*, holds fire fairly, coals slightly. *Ash*, mixed gray, hard. *Colors*, dark mottled. *Texture*, well sweated, medium close grain, dull finish. *Yield*, fairly profitable. *Size*, medium to large. *Vein*, small. *Stem*, medium. *Relative rank*, 18th.

Lot I.

Fertilizers: 2083 lbs. castor pomace, 1254 lbs. cotton hull ashes, 640 lbs. nitrate of soda per acre (the latter in two applications after planting), containing 210 lbs. nitrogen, 205 lbs. phosphoric acid and 340 lbs. of potash. Cost, $59.84 per acre.

Yield: 1310 lbs. long wrappers per acre.
260 " short " " "
Total, 1570 "

Quality:—*Burn*, holds fire well. *Ash*, clear gray, hard. *Colors*, medium, mottled. *Texture*, well sweated, open grain, dull finish. *Yield*, fairly profitable. *Size*, undesirable. *Vein*, fine. *Stem*, medium. *Relative rank*, 15th.

Lot J.

Fertilizers: 2083 lbs. castor pomace, 1254 lbs. cotton hull ashes, and 640 lbs. of nitrate of soda per acre (the latter applied at time of first cultivation), containing 210 lbs. nitrogen, 205 lbs. phosphoric acid and 340 lbs. of potash. Cost, $59.84 per acre.

Yield: 1270 lbs. long wrappers per acre.
320 " short " " "

Total, 1590 "

Quality:—*Burn*, holds fire well. *Ash*, clear gray, hard. *Colors*, clear, dark. *Texture*, well sweated, open grain, fair finish. *Yield*, profitable. *Size*, medium to large. *Vein*, fine. *Stem*, light. *Relative rank*, 5th.

LOT K.

Fertilizers: 1579 lbs. cottonseed meal, 1102 lbs. double sulphate of potash and magnesia, and 457 lbs. Cooper's bone, per acre, containing 105 lbs. nitrogen, 159 lbs. phosphoric acid and 340 lbs. potash. Cost, $40.29 per acre.

Yield: 830 lbs. long wrappers per acre.
270 " short " " "

Total, 1100 "

Quality: *Burn*, holds fire fairly. *Ash*, clear white, hard. *Colors*, medium to light. *Texture*, well sweated, open grain, dull finish. *Yield*, fairly profitable. *Size*, medium to large. *Vein*, medium to small. *Stem*, medium. *Relative rank*, 12th.

LOT L.

Fertilizers: 1579 lbs. cottonseed meal, 1102 lbs. double sulphate of potash and magnesia, 457 lbs. Cooper's bone, and 300 lbs. of lime per acre, containing 105 lbs. nitrogen, 159 lbs. phosphoric acid and 340 lbs. of potash. Cost, $42.27 per acre.

Yield: 640 lbs. long wrappers per acre.
250 " short " " "

Total, 890 "

Quality: *Burn*, holds fire fairly. *Ash*, clear, white. *Colors*, medium to dark. *Texture*, open grain, well sweated, dull finish. *Yield*, unprofitable. *Size*, undesirable. *Vein*, prominent. *Stem*, prominent. *Relative rank*, 23d.

LOT M.

Fertilizers: 1579 lbs. cottonseed meal, 621 lbs. high grade sulphate of potash and 457 lbs Cooper's bone, per acre, containing 105 lbs. nitrogen, 159 lbs. phosphoric acid and 340 lbs. potash. Cost, $39.28 per acre.

Yield: 640 lbs. long wrappers per acre.
250 " short " " "

Total, 890 "

Quality: *Burn*, coals but holds fire fairly. *Ash*, clear gray, hard. *Colors*, light, clear. *Texture*, close grain, fairly sweated, good finish. *Yield*, fairly profitable. *Size*, medium. *Vein*, fine. *Stem*, light. *Relative rank*, 21st.

LOT N.

Fertilizers: 1579 lbs. cottonseed meal, 621 lbs. high grade sulphate of potash, 457 lbs. Cooper's bone and 300 lbs. of lime per acre, containing 105 lbs. nitrogen, 159 lbs. phosphoric acid and 340 lbs of potash. Cost, $41.26 per acre.

Yield: 840 lbs. long wrappers per acre.
310 " short " " "

Total, 1150 "

Quality:—*Burn*, coals slightly, holds fire fairly. *Ash*, clear gray, inclined to flake. *Colors*, medium to dark. *Texture*, well sweated, inclined to close grain, dull finish. *Yield*, unprofitable. *Size*, medium to large. *Vein*, prominent. *Stem*, medium. *Relative rank*, 26th.

LOT O.

Fertilizers: 1579 lbs. cottonseed meal, 578 lbs. carbonate of potash and 457 lbs. Cooper's bone, per acre, containing 105 lbs. nitrogen, 159 lbs. phosphoric acid and 340 lbs. potash. Cost, $72.90 per acre.

Yield: 840 lbs. long wrappers per acre.
310 " short " " "

Total, 1150 "

Quality:—*Burn*, coals slightly, holds fire well. *Ash*, mixed gray, hard. *Colors*, medium to dark, bright. *Texture*, well sweated, open grain, fine finish. *Yield*, very profitable. *Size*, very desirable. *Vein*, fine. *Stem*, light. *Relative rank*, 4th.

LOT P.

Fertilizers: 1579 lbs. cottonseed meal, 1728 lbs. double carbonate of potash and magnesia and 457 lbs. of Cooper's bone, per acre, containing 105 lbs. nitrogen, 159 lbs. phosphoric acid and 340 lbs. potash. Cost, $57.64 per acre.

Yield: 740 lbs. long wrappers per acre.
330 " short " " "

Total, 1070 "

Quality:—*Burn*, perfect, holds fire well. *Ash*, clear white, hard. *Colors*, medium to dark. *Texture*, good open grain, well sweated, fine finish. *Yield*, very profitable. *Size*, desirable. *Vein*, fine. *Stem*, light. *Relative rank*, 1st.

Lot Q.

Fertilizers: 2000 lbs. H. J. Baker's A. A. Ammoniated Superphosphate and 4000 Baker's Tobacco Manure per acre, containing 240 lbs. nitrogen, 453 lbs. phosphoric acid and 434 lbs. potash per acre.

Yield: 900 lbs. long wrappers per acre.
200 " short " " "

Total, 1100 "

Quality:—*Burn*, coals slightly, does not hold fire. *Ash*, mixed gray, hard. *Colors*, medium to dark. *Texture*, open grain, well sweated, dull finish. *Yield*, unprofitable. *Size*, medium to large. *Vein*, fine. *Stem*, medium. *Relative rank*, 24th.

Lot R.

Fertilizers: 2000 lbs. Stockbridge Tobacco Manure and 500 lbs. of the same used as a starter, per acre, containing 154 lbs. nitrogen, 307 lbs. phosphoric acid and 278 lbs. potash, per acre.

Yield: 810 lbs. long wrappers per acre.
240 " short " " "

Total, 1050 "

Quality:—*Burn*, holds fire well, coals slightly. *Ash*, clear gray, hard. *Colors*, clear, light. *Texture*, open grain, well sweated, fine finish. *Yield*, profitable. *Size*, medium to large. *Vein*, curly. *Stem*, medium. *Relative rank*, 7th.

Lot S.

Fertilizers: 3000 lbs. Stockbridge Tobacco Manure and 500 lbs. of the same used as a starter, per acre, containing 215 lbs. nitrogen, 430 lbs. phosphoric acid and 389 lbs. of potash per acre.

Yield: 1110 lbs. long wrappers per acre.
230 " short " " "

Total, 1340 "

Quality:—*Burn*, holds fire well, coals. *Ash*, mixed gray, hard. *Colors*, clear, light. *Texture*, well sweated, fairly open grain, fine finish. *Yield*, profitable. *Size*, medium. *Vein*, fine. *Stem*, medium. *Relative rank*, 8th.

Lot T.

Fertilizers: 945 pounds dry fish scrap, 547 lbs. nitrate of soda, 300 lbs. of lime per acre, containing 175 lbs. nitrogen, 70 lbs. phosphoric acid and no potash. Cost, $32.19 per acre.

Yield: 580 lbs. long wrappers per acre.
140 " short " " "

Total, 720 "

Quality:—*Burn*, does not hold fire, coals. *Ash*, white, flakes. *Colors*, dark, mottled. *Texture*, not well sweated, close grain, no finish. *Yield*, unprofitable. *Size*, undesirable. *Vein*, heavy, curly. *Stem*, coarse. *Relative rank*, 29th.

LOT U.

Fertilizers: 2200 lbs. Mapes' Tobacco Manure, wrapper brand, and 600 lbs. Mapes' Tobacco Starter. per acre, containing 138 lbs. nitrogen, 232 lbs. phosphoric acid and 291 lbs. potash per acre.

Yield: 970 lbs. long wrappers per acre.
210 " short " " "

Total, 1180 "

Quality:—*Burn*, holds fire well, coals very slightly. *Ash*, mixed gray, hard. *Colors*, clear light. *Texture*, well sweated, open grain, fine finish. *Yield*, profitable. *Size*, medium to large. *Vein*, curly. *Stem*, medium to large. *Relative rank*, 13th.

LOT V.

Fertilizers: 2400 lbs. Mapes' Tobacco Manure, wrapper brand, 400 lbs. Mapes' Tobacco Starter, per acre, containing 143 lbs. nitrogen, 219 lbs. phosphoric acid, 309 lbs. potash.

Yield: 790 lbs. long wrappers per acre.
210 " short " " "

Total, 1000 "

Quality:—*Burn*, holds fire fairly well, coals very slightly. *Ash*, mixed gray. *Colors*, clear, light. *Texture*, well sweated, open grain, fine finish. *Yield*, very profitable. *Size*, medium to large. *Vein*, fine. *Stem*, light. *Relative rank*, 3d.

LOT W.

Fertilizers: 2400 Mapes' Tobacco Manure, wrapper brand, per acre, containing 130 lbs. nitrogen, 165 lbs. phosphoric acid, 296 lbs. potash per acre.

Yield: 850 lbs. long wrappers per acre.
210 " short " " "

Total, 1060 "

Quality:—*Burn*, holds fire fairly well. *Ash*, clear gray. *Colors*, clear, light. *Texture*, well sweated, open grain, fine finish. *Yield*, very profitable. *Size*, medium to large. *Vein*, fine. *Stem*, light. *Relative rank*, 2d.

Lot X.

Fertilizers: 2000 lbs. Sanderson's Tobacco Formula per acre, containing 99 lbs. nitrogen, 156 lbs. phosphoric acid and 122 lbs. potash per acre.

Yield: 1000 lbs. long wrappers per acre.
210 " short " " "

Total, 1210 "

Quality:—*Burn*, does not hold fire, coals. *Ash*, mixed gray, hard. *Colors*, dark. *Texture*, medium close grain, well sweated, dull finish. *Yield*, unprofitable. *Size*, undesirable. *Vein*, medium. *Stem*, medium. *Relative rank*, 27th.

Lot Y.

Fertilizers: 1579 lbs. cottonseed meal and 7290 lbs. wood ashes per acre, containing 105 lbs. nitrogen, 214 lbs. phosphoric acid and 340 lbs. potash. Cost, $55.27 per acre.

Yield: 690 lbs. long wrappers, per acre.
270 " short " " "

Total, 960 "

Quality:—*Burn*, holds fire well. *Ash*, clear gray. *Colors*, medium to dark. *Texture*, well sweated, close grain. *Yield*, fairly profitable. *Size*, desirable. *Vein*, fine. *Stem*, light. *Relative rank*, 6th.

Lot Z.

Fertilizers: 1134 lbs. dry ground fish, 1197 lbs. double sulphate of potash and magnesia, 283 lbs. Cooper's bone, per acre, containing 105 lbs. nitrogen, 169 lbs. phosphoric acid and 340 lbs. potash. Cost, $41.74 per acre.

Yield: 710 lbs. long wrappers per acre.
260 " short " " "

Total, 970 "

Quality:—*Burn*, holds fire well. *Ash*, clear, white, hard. *Colors*, dark, mottled. *Texture*, well sweated, medium open grain, dull finish. *Yield*, unprofitable. *Size*, medium to large. *Vein*, curly. *Stem*, medium. *Relative rank*, 11th.

Lot AA.

Fertilizer: 10 to 12 cords of stable manure per acre, containing 111 lbs. nitrogen, 71 pounds phosphoric acid, 149 lbs. potash per acre.

Yield: 580 lbs. long wrappers per acre.
250 " short " " "

Total, 830 "

Quality:—*Burn*, holds fire fairly. *Ash*, clear white, hard. *Colors*, medium to light. *Texture*, well sweated, open grain, dull finish. *Yield*, fairly profitable. *Size*, medium to large. *Vein*, medium to small. *Stem*, medium. *Relative rank*, 17th.

Lot BB.

Fertilizers: 6000 lbs. tobacco stems and 2894 lbs. castor pomace per acre, containing 239 lbs. nitrogen, 74 lbs. phosphoric acid and 517 lbs. potash. Cost, $63.71 per acre.

Yield: 1250 lbs. long wrappers per acre.
270 " short " " "
Total, 1520 "

Quality:—*Burn*, coals, holds fire fairly. *Ash*, mixed gray. *Colors*, medium to dark. *Texture*, well sweated, medium close grain. *Yield*, unprofitable. *Size*, medium to large. *Vein*, small. *Stem*, medium. *Relative rank*, 19th.

Lot CC.

Fertilizers: 3000 lbs. Pinney's Formula Fertilizer per acre, containing 131 lbs. nitrogen, 196 lbs. phosphoric acid and 305 lbs. potash per acre.

Yield: 740 lbs. long wrappers per acre.
230 " short " " "
Total, 970 "

Quality:—*Burn*, holds fire fairly, coals slightly. *Ash*, mixed gray, hard. *Colors*, dark, mottled. *Texture*, fairly sweated, medium close grain, dull finish. *Yield*, unprofitable. *Size*, medium to large. *Vein*, medium. *Stem*, medium. *Relative rank*, 20th.

The lots in order of their value as wrappers, taking all points into consideration, are graded as follows:

P (best),	W,	V,	O,	J,	Y,	R,	S,	D,	B,	Z,	K,
1st.	2d.	3d.	4th.	5th.	6th.	7th.	8th.	9th.	10th.	11th.	12th.

U,	A,	I,	F,	AA,	H,	BB,	CC,	M,	E,	L,
13th.	14th.	15th.	16th.	17th.	18th.	19th.	20th.	21st.	22d.	23d.

Q,	C,	N,	X,	G,	T (poorest).
24th.	25th.	26th.	27th.	28th.	29th.

The first five in the above list differ *very* little in quality.

Discussion of the Results.

The season of 1895 was more favorable to the growth of tobacco than either 1893 or 1894. On only nine days was the soil of the experiment field too dry, in the opinion of the Superintendent.

June was a dry month, no rain falling from the 6th to the 25th, but after this time more or less rain fell in every week, so that the water content of the soil to the depth of eight inches was practically the same throughout the growing season. The rain-fall during the time that the tobacco was on the land, in the several years of our experiment, has been:

In 1892	16.01 inches.
1893	6.13 "
1894	7.16 "
1895	9.38 "

Comparative Fire-Holding Capacity.

In the table on the opposite page is given the relative fire-holding capacity of the long and short wrappers from each plot, determined by Messrs. Winton and Ogden, by the method described in the Report of this Station for 1893, p. 124.

The lot which held fire the shortest time is marked 100, and the other lots are so marked as to express numerically their capacity for holding fire ; for example, lot T held fire for a shorter time than any other (100), lot A held fire more than three times as long (325).

The fire-holding capacity of the leaf was in every case increased by the fermentation, though not by any means equally in all cases.

The *average* fire-holding capacity of the four years' crops already fermented are:

	Before Fermentation.	After Fermentation.
Crop of 1892	9.6 Seconds.	24.4 Seconds.
Crop of 1893	9.0 "	18.0 "
Crop of 1894	9.7 "	23.2 "
Crop of 1895	14.7 "	33.3 "

The opinion of the expert that the "burn" of the 1895 crop was better than that of any previous one is in accord with the results of these laboratory tests.

There is substantial agreement in most cases between the judgment as to fire-holding capacity by the expert and the results of these laboratory tests.

Thus the three lots, X, T, and Q, which "did not hold fire" in

the judgment of the expert, were found to hold fire 13.1, 10.2, and 15.2 seconds respectively, less than half the average length of time.

The average fire-holding capacity of the lots which held fire "well" in the expert's opinion, was 36.1 seconds, ranging from 23.8 to 55.9, and that of the lots which in his judgment held fire "fairly" was 33.8 seconds, ranging from 24 to 43.7 seconds.

COMPARATIVE FIRE-HOLDING CAPACITY. FERMENTED CROP, 1895.

Plot.	Long Wrappers.	Short Wrappers.	Calculated from mean of both.	Average number of seconds during which leaf holds fire. Unfermented.	Fermented.
A	370	282	326	19.5	33.1
B	276	393	336	17.8	34.3
C	395	459	428	16.4	43.7
D	370	431	402	18.6	41.0
E	404	431	419	22.3	42.7
F	507	467	486	14.9	49.6
G	369	459	416	16.1	42.4
H	206	262	235	12.2	24.0
I	285	234	259	27.3	26.4
J	327	256	291	13.5	29.7
K	217	379	301	12.4	30.7
L	411	373	392	14.0	40.0
M	274	357	317	11.6	32.3
N	267	516	395	12.4	40.3
O	361	378	370	19.8	37.7
P	541	470	505	13.8	51.5
Q	138	158	149	8.3	15.2
R	250	306	279	12.7	28.5
S	247	330	290	12.2	29.6
T	100	100	100	6.6	10.2
U	218	247	233	10.0	23.8
V	199	292	247	10.5	25.2
W	392	288	338	15.2	34.5
X	105	150	128	5.6	13.1
Y	425	663	548	23.8	55 9
Z	354	220	285	13.9	29.1
AA	318	469	396	17.8	40.4
BB	352	326	339	14.6	34.6
CC	182	331	259	11.5	26.4

NUMBER OF FERMENTED LEAVES TO THE POUND.

On page 154, Report of 1895, are given the number of leaves per pound of each lot of *pole-cured* tobacco of this crop.

The number of leaves per pound of this same crop after fermentation in the case, appears in the following table.

From 25 to 35 leaves were weighed on a balance sensitive to $\frac{1}{30}$ of an ounce, and from these weights the results in the table are computed.

NUMBER OF FERMENTED LEAVES TO THE POUND. CROP OF 1895.

Plot.	Long Wrappers.	Short Wrappers.	Plot.	Long Wrappers.	Short Wrappers.
A	54	84	P	80	94
B	66	95	Q	60	83
C	57	84	R	56	89
D	70	73	S	56	92
E	63	84	T	52	86
F	70	84	U	56	83
G	52	73	V	51	83
H	58	89	W	67	103
I	47	80	X	56	80
J	54	92	Y	69	89
K	55	89	Z	71	88
L	54	78	AA	63	79
M	58	73	BB	56	54
N	56	86	CC	61	103
O	60	86			

The average number of leaves per pound, before and after fermenting, are as follows:

CROP OF 1895. NUMBER OF LEAVES TO THE POUND.

	Pole-cured.	Fermented.
Short wrappers	79	85
Long wrappers	55	60

EFFECTS OF DIFFERENT FORMS OF NITROGEN.

Cottonseed Meal and Castor Pomace.

Plots A, C and D received 105, 175 and 210 pounds of nitrogen respectively, per acre, in form of cottonseed meal, together with about 150 pounds of phosphoric acid and 340 pounds of potash in form of cotton hull ashes.

Plots E, G and H each received the same quantities of cotton hull ashes and 105, 175 and 210 pounds of nitrogen respectively, per acre, but the latter in form of castor pomace.

The largest amount of fertilizer-nitrogen yielded in each case the largest crop.

The yield of wrapper leaf grown on these two fertilizers was practically the same, there being an average difference of only 35 pounds to the acre in favor of the castor pomace, which yielded 1,300 pounds of wrapper leaf per acre. The per cent. of wrapper leaves in the crops and the number of wrapper leaves per pound was also practically the same.

The lots A, C, D (cottonseed meal) were graded 14th, 25th and 9th. The lots E, G, H (castor pomace) were graded 22d, 28th and 18th.

The average quality of the leaf raised on cottonseed meal was therefore rather better than that raised on castor pomace.

Linseed Meal.

Plot B was dressed with 105 pounds of nitrogen per acre in form of linseed meal and with the same amount of cotton hull ashes as A and E, which received their nitrogen in form of cottonseed meal and castor pomace.

Plot B yielded nearly as much wrapper leaf as Plot A (cottonseed meal), a larger proportion being short wrappers. The number of leaves to the pound was larger and in other respects the quality was somewhat better, being graded 10th. Plot F, with the same amount of linseed meal and phosphoric acid but half the quantity of potash that was put on B, yielded considerably less tobacco and was graded 16th.

Fish.

Plot L was dressed with dry ground fish, which supplied 105 pounds of nitrogen per acre, and with 1,260 pounds of double sulphate of potash and magnesia. This plot yielded 80 pounds less of wrappers per acre than A (cottonseed meal) and 340 pounds less than E (castor pomace). The quality of leaf was quite as good as either and was graded 11th.

Plot T, which received 175 pounds of nitrogen per acre in form of fish and nitrate of soda, *with no potash*, produced but a small quantity of wrappers of very inferior quality;—the only lot of really bad tobacco in the whole experiment field.

Nitrate of Soda, at First and Second Cultivation.

This experiment is to ascertain the effect on the crop of supplying one-third of the nitrogen of a heavy application (210 pounds per acre) as a top dressing in the form of nitrate of soda, either in one application at the time of first cultivation (Plot I), or in two applications at the time of the first and second cultivation (Plot J).

In this year the effect has been to increase the yield of wrapper leaf over that of plot H, which was dressed with the same amount of nitrogen all in the form of castor pomace, and the quality of the leaf is also somewhat better, lots I and J being

graded 15th and 5th respectively, H being 18th. Different results have been obtained in previous crops, and on the whole this method of fractional fertilization has not been successful.

Stable Manure.

Plot AA was dressed in 1895 with from 10 to 12 cords of stable manure, but no "starter" or other commercial fertilizer was added, as it was thought the land was now rich enough in plant food to dispense with anything more than the manure itself supplied.

The yield of wrappers was the smallest on the whole field excepting plot T, and the quality of the crop was not more than average, and was graded 17th. In 1894, this plot was dressed with Swift-Sure Superphosphate in addition to the stable manure, and the crop, though quite small (560 pounds of wrappers per acre) was of better quality than any other in the field.

Tobacco Stems.

Plot BB, dressed with 3 tons of tobacco stems to the acre and nearly 3,000 pounds of castor pomace, yielded one of the largest crops of wrappers (1,520 pounds per acre), of rather less than average quality, graded 19th.

EFFECT OF DIFFERENT FORMS OF POTASH.

Plots A, K, L, M, N, O, P and Y were dressed with like quantities of nitrogen (in form of cottonseed meal), phosphoric acid and potash; but the potash was supplied in different forms.

The results of the experiments are summarized in the following table:

Plot.	Source of Potash.	Weight of wrappers. Long.	Short.	No. of wrapper leaves in a pound. Long.	Short.	No. of seconds during which leaf holds fire.	Relative rank.
P	Double carbonate potash and magnesia	740	330	80	94	52	1st
O	Carbonate of potash	840	310	60	86	38	4th
Y	Wood ashes	690	270	69	89	56	6th
A	Cotton hull ashes	830	220	54	84	33	14th
K	Double sulphate potash and magnesia	830	270	55	89	31	12th
L	Double sulphate potash and magnesia with lime	640	250	54	78	40	23d
M	High grade sulphate of potash and magnesia	640	250	58	73	32	21st
N	High grade sulphate of potash and magnesia with lime	840	310	56	86	40	26th

The results of these experiments agree in the main with the corresponding ones made in the three previous years. The various forms of carbonate of potash have yielded on the whole better tobacco than the sulphates, and the low grade sulphate has produced better tobacco than the high grade. Tobacco raised on high grade sulphate has each year shown a tendency to "coal" on the cigar even when it was free-burning.

The above summary presents briefly the results of the experiments of 1895. The experiments of 1896 close the series. The crop of 1896 is now in the case for fermentation and will be examined by the expert in the fall of 1897. A complete review of the whole five years' work can then be given.

EXPERIMENTS IN GROWING TOBACCO WITH DIFFERENT FERTILIZERS. SEASON OF 1896.

By E. H. Jenkins.

These experiments are in continuation of those begun in 1892 in coöperation with the Connecticut Tobacco Experiment Co. of Poquonock in the town of Windsor.

Full particulars regarding the land, the conduct of the experiments and their results are given in the Reports of this Station for 1892, pages 1 to 24; for 1893, pages 112 to 144; for 1894, pages 254 to 284; for 1895, pages 128 to 156.

Fertilizers.

The fertilizers used in 1896 were sampled and analyzed by Messrs. Winton, Ogden and Mitchell with the following results:

Composition and Cost of Fertilizers Used.

	Cost Per Ton.	Percentage Composition. Nitrogen.	Phosphoric Acid.	Potash.
Nitrate of Soda	$45.00	16.00	....	....
Cotton Seed Meal	23.50	7.38	3.28	1.93
Castor Pomace	20.00	4.72	1.89	1.06
Linseed Meal	18.00	6.72	1.89	1.30
Tobacco Stems	12.00	1.90*	.60*	8.10*
Cooper's Bone	28.00	2.33	27.89	....
Cotton Hull Ashes	45.00	....	8.99	25.48
Wood Ashes	15.00	....	....	4.58
High Grade Sulphate of Potash	50.00	....	....	48.98
Carbonate of Potash	170.00†	....	....	54.10
Double Carbonate Potash and Magnesia	39.00‡	....	....	18.10
Double Sulphate Potash and Magnesia	30.00	....	....	26.44
Fish	35.00	8.33	6.84	....

The chemicals used for each plot were accurately weighed and labeled by the Station representative, mixed thoroughly and bagged by Mr. DuBon and himself.

The bags were carried to the several plots by Mr. DuBon, and their contents were sowed under his constant supervision.

* Estimated. † By single pound; ton rates would be much lower.

‡ Total cost of importing a one ton lot from Stassfurt.

The following table shows the plan of the experiment, the fertilizers applied, with the cost of each as far as known, and the quantities of nitrogen, phosphoric acid and potash contained in them.

FERTILIZERS APPLIED, SEASON OF 1896.

Name of Plot.	FERTILIZERS APPLIED. Pounds per Acre.	Cost per Acre.	Fertilizer contains pounds. Nitrogen.	Phosphoric Acid.	Potash.
A	1423 Cotton Seed Meal 1227 Cotton Hull Ashes	$44.50	105	157	340
B	1562 Linseed Meal 1254 Cotton Hull Ashes	42.28	105	143	340
C	2371 Cotton Seed Meal 1156 Cotton Hull Ashes	53.99	175	182	340
D	2845 Cotton Seed Meal 1121 Cotton Hull Ashes	59.58	210	195	340
E	2225 Castor Pomace 2141 Cotton Hull Ashes	50.17	105	152	340
F	1562 Linseed Meal 509 Cotton Hull Ashes 242 Cooper's Bone	28.90	105	143	150
G	3707 Castor Pomace 1180 Cotton Hull Ashes	63.62	175	177	340
H	4450 Castor Pomace 1150 Cotton Hull Ashes	70.37	210	188	340
I	2225 Castor Pomace 1241 Cotton Hull Ashes 328 Nitrate of Soda* 326 Nitrate of Soda†	64.93	210	152	340
J	2225 Castor Pomace 1241 Cotton Hull Ashes 656 Nitrate of Soda	64.93	210	152	340
K	1423 Cotton Seed Meal 1182 Double Sulphate of Potash and Magnesia 396 Cooper's Bone	40.06	105	157	340
L	1423 Cotton Seed Meal 1182 Double Sulphate of Potash and Magnesia 396 Cooper's Bone 300 Lime	42.04	105	157	340
M	1423 Cotton Seed Meal 638 High Grade Sulphate of Potash 396 Cooper's Bone	38.28	105	157	340

* Applied between the rows July 7. †Applied between the rows July 20.

FERTILIZERS APPLIED, SEASON OF 1896.

Name of Plot.	FERTILIZERS APPLIED. Pounds per Acre.	Cost per Acre.	Fertilizer contains pounds. Nitrogen.	Phosphoric Acid.	Potash.
N	1423 Cotton Seed Meal 638 High Grade Sulphate of Potash 396 Cooper's Bone 300 Lime	40.26	105	157	340
O	1423 Cotton Seed Meal 578 Carbonate of Potash 396 Cooper's Bone	$71.46	105	157	340
P	1423 Cotton Seed Meal 1724 Double Carbonate Potash and Magnesia 396 Cooper's Bone	55.94	105	157	340
Q	2000 Baker's A. A. Superphosphate 4000 Baker's Tobacco Manure	----	238	452	522
R	2000 Stockbridge Tobacco Manure	----	116	227	202
S	3000 Stockbridge Tobacco Manure	----	174	340	303
T	1050 Dry Ground Fish 550 Nitrate of Soda 300 Lime	32.83	142	71	----
U	2000 Mapes' Tobacco Manure, Wrapper Brand	----	120	114	212
V	2400 Mapes' Tobacco Manure, Wrapper Brand 400 Mapes' Starter	----	157	190	268
W	2400 Mapes' Tobacco Manure, Wrapper Brand	----	145	136	254
X	2000 Sanderson's Formula for Tobacco	----	88	241	172
Y	1423 Cotton Seed Meal 6825 Wood Ashes	66.79	105	150	340
Z	1260 Dry Ground Fish 1211 Double Sulphate of Potash and Magnesia 256 Cooper's Bone	43.79	104	86	340
AA	Stable Manure 10–12 cords*	----	111	71	149
BB	3091 Tobacco Stems	36.00	111	36	486
CC	3000 Pinney's Formula Fertilizer	----	131	196	305

* Estimated to contain 111 lbs. nitrogen, 71 lbs. phosphoric acid and 119 lbs. potash.

Plowing, Planting and Care During Growth.

On April 7th and again on April 14th, the field was harrowed.

The fertilizers were evenly broadcast on the several plots, May 11th, and plowed in. The field was again harrowed on the 12th.

A few weeks before the plants were set, the field was found to be infested with cut-worms which fed upon the young weeds as they came up.

To rid the land of cut-worms, small handfuls of an even mixture of 500 pounds of damp wheat bran and 5 pounds of Paris green were dropped, about 2 paces apart, on the rows where tobacco plants were to be set. Multitudes of the worms were found, poisoned by this mixture.

The tobacco plants were set with the Bemis planter, on May 25th, 12 days after the application of Paris green. In former years a good many plants have been eaten by cut-worms the night after planting; this year not a single plant was found to be injured.

On May 30 about 100 plants in all had been destroyed by cut-worms or wire worms, and were replaced. On June 6th about 50 more were replaced. No further damage was done by worms. In each of the four previous years the cut-worms have killed large numbers of plants and in consequence the stand of tobacco has been uneven.

July 14th the first topping of the tobacco was done, about half the plants requiring it. The others were topped on the 18th. The crop was harvested on Aug. 11th and 12th.

Copious rains fell after the tobacco was set, but the crop did not start as promptly nor grow as vigorously through the season as the year before. It is probable that a part of the fertilizer was either carried out of reach of the young plants by the rains, immediately after planting, or that the roots were slow to reach it.

In 1892 excellent results followed from harrowing in the fertilizer lightly; (abundant rain followed planting).

In 1893, the fertilizer was harrowed in, but the plants were somewhat "burned" by the fertilizer; (little rain followed planting).

In 1895, excellent results followed from plowing in the fertilizer; (rather dry weather followed planting).

In 1896, the fertilizer was plowed in as in 1895, but the crop was slow in starting and backward in development till near harvest time; (abundant rains followed planting).

It is likely that soluble plant food moves easily in the very light sandy soils on which tobacco is grown, following the movement of water in the soil.

If the land is dressed with large amounts of fertilizer chemicals which are only harrowed in, and if very dry weather follows planting the tender plants may be burned, but if the fertilizer is plowed in, it is distributed in moister soil, where the roots strike down for water.

If, on the other hand, copious rain immediately follows planting, the fertilizer which has been lightly harrowed in may be carried down no further than the roots easily reach, while, if plowed in, it may be carried by the rains below this point and so be in part at least lost to the crop.

At planting time, therefore, it is not possible to determine which way of putting in fertilizer will give the better results.

Rainfall.

The rainfall during the growing season, measured in a standard rain-gauge by Mr. Adelbert DuBon, was as follows:

Date.		Inches of rainfall.	Date.		Inches of rainfall.
May	28	1.00	July	7	0.19
"	31	0.60	"	9	0.20
June	9	0.33	"	16	0.26
"	10	1.63	"	21	0.25
"	14	1.75	"	24	0.65
"	16	0.82	"	27	0.23
"	21	0.09	Aug.	2	0.73
July	4	0.63	"	9	0.12
"	5	0.32	"	14	1.24

Total, 11.04 inches.

The tobacco crop, from setting time to harvest, was in the field 79 days. On 18 or more of those days rain fell, and the longest period during which there was no rain was 13 days.

Observations of soil temperature and moisture were not made in 1896.

Harvesting, Curing, Stripping and Sorting.

The crop was harvested on Aug. 12th.

The weather was generally favorable during the period of curing, and the pole-cured crop showed neither pole-burn nor white vein.

It was taken down from the poles, cured, on Oct. 6th, and was stripped and bundled on the 7th. The sorting was begun on Oct. 26th and was finished on the 31st.

At each handling of the crop a representative of the Station was present; all weights were made and recorded, and samples drawn by him.

As the crops were sorted, samples were carefully drawn from each lot of long and short wrappers and labeled as described in the Report for 1893, p. 138. These samples were for laboratory examinations and for fermentation.

The following table gives the results of the sorting. The weights are in pounds.

For those unfamiliar with the details of sorting leaf-tobacco, it may be said that the "seconds" are the lower leaves on the stalk ("sand leaves"), smaller than those of either of the other grades, over-ripe and unfit for wrappers. The "long wrappers" and "short wrappers" are the most valuable part of the crop, the latter being smaller and lighter, and much used for cigar binders. The "top leaves" are often as large as the long wrappers, but heavier, darker in color and unripe.

WEIGHTS, IN POUNDS, OF THE BARN-CURED LEAVES FROM $\frac{1}{10}$ ACRE.
CROP OF 1896.

Plot.	Long Wrappers.	Short Wrappers.	Top Leaves.	Seconds.	Total.
A	41¼	13½	16¾	9½	81
B	30	12¾	17½	12	72¼
C	40¾	14½	14¼	8½	77¾
D	47½	13¾	17¼	8¼	86¾
E	42¾	13½	18¾	10¾	85¾
F	20	10¾	17¾	12	60½
G	40¾	13½	16¾	9¾	80¾
H	47	13¾	15½	12½	88¾
I	45½	14	18¼	9	86¾
J	43½	14½	17¾	9¾	85
K	45½	14½	16¼	8½	84
L	32½	11½	18½	14	75¾
M	32¾	12½	20¾	11	77
N	40¾	14½	18½	8½	81¾
O	34	14½	15	8½	72
P	26¼	13¼	12¾	10½	62¾
Q	26¾	11	17¾	14½	70
R	32½	11¼	19½	12½	75¾
S	36	12¾	18½	9½	76¾
T	--	--	--	--	69*
U	42⅜	12⅜	18	10⅞	83⅝
V	37⅛	11⅝	19½	9	77¼
W	27⅝	10½	16⅞	9⅝	64⅝
X	30	11¼	16¼	11¼	68¾
Y	31¾	10	16½	11½	69¾
Z	37½	12½	16¼	10	76¼
AA	32⅛	8	18	10¼	68⅜
BB	41½	14¾	15	8	79¼
CC	27	12¼	17	9¼	65½

* Crop very poor in quality. Not sorted.

PER CENT. OF THE FOUR DIFFERENT GRADES.

POLE-CURED CROP OF 1896.

Plot.	Long Wrappers.	Short Wrappers.	Total per cent. of Wrappers.	Top Leaves.	Seconds
A	52	16	68	21	11
B	42	18	60	24	16
C	52	18	70	19	11
D	55	16	71	20	9
E	50	16	66	22	12
F	33	17	50	29	21
G	50	17	67	21	12
H	53	16	69	17	14
I	52	16	68	21	11
J	51	17	68	20	12
K	54	17	71	19	10
L	43	15	58	24	18
M	42	16	58	27	15
N	49	18	67	22	11
O	47	20	67	21	12
P	42	21	63	20	17
Q	38	16	54	25	21
R	43	15	58	25	17
S	47	17	64	24	12
T	--	--	--	--	--
U	50	15	65	21	14
V	48	15	63	25	12
W	42	16	58	26	16
X	44	16	60	24	16
Y	46	14	60	23	17
Z	49	16	66	21	13
AA	47	12	59	26	15
BB	52	19	71	19	10
CC	41	19	60	26	14

COMPARATIVE FIRE-HOLDING CAPACITY.

POLE-CURED CROP, 1896.

The method of determining the fire-holding capacity is described in the Station Report for 1892, page 17, and the meaning of the figures in the following table is described on page 296 of the present report.

Plot.	Long Wrappers.	Short Wrappers.	Calculated from the average of both.	Plot.	Long Wrappers.	Short Wrappers.	Calculated from the average of both.
A....	330	259	290	P...	214	159	183
B....	274	237	253	Q...	100	100	100
C....	306	236	267	R...	183	144	161
D ...	223	165	190	S ...	157	137	146
E. ..	188	158	171	T...	...	...	...
F....	185	218	205	U...	165	132	147
G....	208	157	177	V...	146	220	190
H....	151	143	147	W ..	206	167	184
I	229	211	220	X...	131	109	119
J	201	249	231	Y...	288	239	262
K....	137	109	121	Z ...	129	149	141
L....	171	117	140	AA .	163	134	148
M....	121	119	121	BB ..	241	158	194
N....	135	113	123	CC ..	126	114	119
O....	187	169	177				

NUMBER OF POLE-CURED LEAVES TO THE POUND.

CROP OF 1896.

Plot.	Long Wrappers.	Short Wrappers.	Plot.	Long Wrappers.	Short Wrappers.
A	60	85	P	63	81
B	63	87	Q	58	75
C	56	82	R	54	91
D	57	68	S	64	92
E	51	83	T	--	--
F	76	102	U	63	72
G	65	78	V	61	86
H	51	79	W	62	97
I	59	83	X	61	91
J	64	83	Y	89	106
K	56	86	Z	60	88
L	54	88	AA	62	92
M	61	95	BB	59	92
N	60	84	CC	72	98
O	70	72			

The average number of short wrapper leaves to the pound was 86; of the long wrapper leaves 62.

SOME RESULTS OF THE EXPERIMENTS WITH TOBACCO FERTILIZERS FOR THE FIVE YEARS, 1892–1896.

By E. H. Jenkins.

These experiments, begun in 1892, with the co-operation of the Connecticut Tobacco Experiment Co., have been made for five consecutive years. The crop of 1896, described in the preceding paper, completes the series. Samples of this crop are now cased down for fermentation and cannot be graded as to their quality until October or November, 1897.

Final discussion of the quality of the tobacco from the several plots must, of course, be reserved till that time.

We may, however, compare the average yields of these plots for the five-year period and examine those qualities of the crop which have been determined in the unfermented leaves.

1. Effect of the Quantity of Fertilizer-nitrogen on the Amount and Quality of the Crop.

Plots A, C, D, E, G and H have received annually, for five years, 340 pounds of potash and from 140 to 190 pounds of phosphoric acid per acre, chiefly in form of cotton hull ashes.*

Plots A, C and D have also received annually cottonseed meal, and plots E, G and H, castor pomace, in such quantities that plots A and E had annually 105 pounds of nitrogen per acre, plots C and G 175 pounds and plots D and H 210 pounds of fertilizer-nitrogen. Table I shows the statistics of the crops.

* The only other source of potash and phosphoric acid has been the nitrogenous matter (cottonseed meal or castor pomace), which supplied a comparatively small amount. This large quantity of potash was used because experienced growers suggested it and it agrees with a common practice. We believe the amount is much larger than is generally required. The amount of phosphoric acid, too, is probably largely in excess of the crop requirements, but as it came from the ashes used, the quantity could not be made less without lessening the potash supplied.

TABLE I.—TOBACCO EXPERIMENT, 1892–1896. EFFECT OF DIFFERENT AMOUNTS OF NITROGEN. YEARLY AVERAGES.

	Fertilizer-nitrogen.		Tobacco Crop, pounds per acre.				No. of pole-cured Leaves to pound.		No. of seconds holds fire.	
Plot.	Source of Nitrogen.	Pounds per acre.	Total.	Long Wrap.	Short Wrap.	Percentage of Wrap.	Long Wrap.	Short Wrap.	Long Wrap.	Short Wrap.
A	Cotton Seed Meal	105	1615	740	245	61	66	89	14	15
E	Castor Pomace ..	105	1760	803	203	60	59	84	10	15
	Average....		**1688**	**772**	**224**	**61**	**63**	**87**	**12**	**15**
C	Cotton Seed Meal	175	1673	795	276	64	61	85	12	14
G	Castor Pomace ..	175	1700	769	267	61	62	81	10	13
	Average....		**1687**	**782**	**272**	**63**	**62**	**83**	**11**	**14**
D	Cotton Seed Meal	210	1839	957	268	67	60	85	10	15
H	Castor Pomace ..	210	1863	996	271	68	60	84	10	12
	Average....		**1851**	**977**	**269**	**68**	**60**	**85**	**10**	**14**

Table I shows that

1. 210 pounds of fertilizer-nitrogen per acre, either in form of castor pomace or cottonseed meal, have given a larger crop of tobacco annually for five years than either 105 or 175 pounds of fertilizer-nitrogen.

This gain has been in wrapper-leaf altogether; the more valuable part of the crop. The percentage of wrapper-leaf in the crop was 68 when 210 pounds of fertilizer-nitrogen were used, 63 and 61 when smaller quantities of fertilizer-nitrogen were applied.

Where 210 pounds of fertilizer-nitrogen were used, the pole-cured wrapper-leaves were very slightly heavier (60 long wrapper-leaves, 85 short wrapper-leaves to the pound) than those raised with smaller amounts of fertilizer-nitrogen (63 long wrappers, 87 short wrappers per pound). The difference in fire-holding capacity was too slight to have significance.

2. The plot having 210 pounds of nitrogen in form of cottonseed meal produced 224 pounds more of crop than the one having 105 pounds of nitrogen. At 12½ cents per pound this gain amounts to $28.06 per acre. The increased amount of fertilizer, 1500 pounds, at $25.00 per ton, costs $18.75, so that it has paid to use the larger quantity of fertilizer—provided the quality of the leaf was not damaged by it.

The quality of the 1896 crop cannot be determined till the fall of 1897, but the tobacco from plots having the largest quantity of fertilizer-nitrogen, whether cottonseed meal or castor pomace, has, on the average of four years' crops, been of better quality than that from plots with smaller amounts of fertilizer-nitrogen.

Can Part of a Heavy Dressing of Nitrogen be Advantageously Applied in Form of Nitrate of Soda, During the Growing Season?

(Plots I and J compared with H.)

The same quantities of cotton hull ashes were put on plots H, I and J for five years. The same quantities of nitrogen (210 pounds) were also put on these three plots.

But while the nitrogen applied to plot H was all in form of castor pomace, plots I and J received only 105 pounds of nitrogen per acre, in form of castor pomace, and the other 70 pounds in form of nitrate of soda, either in one application, plot J, or in two, plot I.

Following are the results:

Table II.—Effect of Nitrate of Soda Added During the Growing Season. Yearly Averages.

Source of Nitrogen.	Plot H. Castor Pomace.	Plot I. Castor Pomace and Nitrate of Soda.	Plot J. Castor Pomace and Nitrate of Soda.
Amount of Fertilizer-Nitrogen,			
pounds per acre	210	210	210
Yield of leaf tobacco in pounds,			
Total	1863	1860	1932
Long wrappers	996	973	1040
Short "	271	273	293
Per cent. of wrappers in Crop	68	67	69
No. of pole-cured leaves in 1 pound			
long wrappers	60	63	65
short "	84	83	80
No. of seconds holds fire, long wrap-			
pers	10	9	10
Short wrappers	12	15	16

The average yield of tobacco as well as the yield of wrapper leaves was decidedly larger on plot J, which received part of its nitrogen in a single application of nitrate of soda after the crop was nearly half grown, than on either of the other plots; the individual leaves were no heavier, nor was there any perceptible difference in fire-holding capacity. The quality of the wrapper leaf must determine whether the practice is a profitable one. The indications are that the quality of the crops, where nitrate of soda was applied after the plants were partly grown, was inferior to that of plot H, to which no nitrate was added.

Comparison of Cotton Seed Meal and Castor Pomace as Tobacco Fertilizers.

Table I, page 311, gives the data necessary for this comparison. The crops fertilized with castor pomace have been uniformly larger than those fertilized with cottonseed meal, the average yearly difference for five years being 111 pounds per acre, and the difference in wrapper leaf being 25 pounds annually, in favor of castor pomace. There has been no significant difference in the weight of 100 wrapper leaves or in the fire-holding capacity.

At 12½ cents per pound, 111 pounds of tobacco would bring $13.87. As the average cost of nitrogen in castor pomace has been four cents more per pound than in cottonseed meal during the five years of this experiment, 210 pounds of fertilizer-nitrogen from castor pomace have cost $8.40 more than the same quantity of nitrogen from cotton seed. So that the net annual profit from the use of castor pomace instead of cottonseed meal is not more than $5.47 per acre, *provided the quality of the crop is the same.*

For four years the relative rank of the tobaccos grown on the several plots named in the table above has been—

Table III. — Quality of the Tobacco from Plots Named, Expressed by the Relative Rank.

	105 lbs. Nitrogen.		175 lbs. Nitrogen.		210 lbs. Nitrogen.	
	Plot A. Cotton Seed Meal.	Plot E. Castor Pomace.	Plot C. Cotton Seed Meal.	Plot G. Castor Pomace.	Plot D. Cotton Seed Meal.	Plot H. Castor Pomace.
1892 ...	10th	16th	2d	4th	3d	5th
1893 ...	23	29	5	22	8	9
1894 ...	5	28	11	15	16	14
1895 ...	14	22	25	28	9	18
Average.	**13th**	**24th**	**11th**	**17th**	**9th**	**11th**

The relative quality of tobacco from plots A, C, D, dressed with different amounts of cottonseed meal, has been 13th, 11th, 9th. The relative quality of the corresponding plots dressed with castor pomace has been 24th, 17th, 11th.

It is therefore quite clear that the average quality of the tobacco raised with cottonseed meal has been somewhat better than that of tobacco raised with castor pomace.

Comparison of Linseed Meal with Cotton Seed Meal and Castor Pomace.

(Plot B compared with plots A and E.)

This test was begun in 1893 and has therefore been carried on for only four years.

Plot B was annually dressed with the same quantity of cotton hull ashes as plots A and E, but was dressed with 105 pounds of nitrogen per acre, in form of linseed meal, while A and E received like amounts of nitrogen in form of cottonseed meal and castor pomace, respectively.

The data for the comparison are as follows:

TABLE IV. — COMPARISON OF LINSEED MEAL WITH COTTON SEED MEAL AND CASTOR POMACE.

Source of Nitrogen.	Plot B.* Linseed Meal.	Plot A.* Cotton Seed Meal.	Plot E.* Castor Pomace.
Amount of Nitrogen per acre, pounds	105	105	105
Average annual yield in pounds, Total	1501	1585	1740
Long wrappers	664	732	820
Short wrappers	222	219	223
Per cent. of Wrappers in Crop	59	60	60
No. of pole-cured leaves in 1 pound long wrappers	61	63	57
Short wrappers	85	85	81
No. of seconds holds fire, long wrappers	12	14	10
short "	15	15	15

These data show that the average total yield of tobacco from linseed meal, in the four years of the test has been somewhat less than from cottonseed meal and considerably less than from castor pomace. There is a corresponding difference in the weight of the wrapper leaves.

Three of the four crops have been examined and graded as to quality. The relative ranks of those crops raised on linseed meal, plot B, were 1st, 6th, 10th, while those raised on cottonseed meal were, in the same years, 23d, 5th, 14th, and on castor pomace 29th, 28th and 22d.

In the three years of which we have complete data less tobacco was raised on linseed meal than on equivalent quantities of either castor pomace or cottonseed meal, but the quality of leaf raised on linseed meal was better than that from the other forms of nitrogen.

COMPARISON OF FISH WITH COTTON SEED MEAL AS A FERTILIZER FOR TOBACCO.

(Plot Z compared with plot K.)

Plots Z and K in 1893 and the following years were dressed with like quantities of bone and double sulphate of potash and magnesia. Each plot also received annually 105 pounds of nitrogen, plot Z in form of dry ground fish, plot K in form of cotton seed meal. The data regarding the crops are given below:

* For the years 1893–1896 only.

TABLE V.—COMPARISON OF FISH WITH COTTON SEED MEAL AS A TOBACCO FERTILIZER.

Source of Nitrogen.	Plot Z.* Dry Fish.	Plot K.* Cotton Seed Meal.
Amount of Nitrogen per acre, pounds	105	105
Average annual yield of tobacco in pounds, total	1496	1740
Long wrappers	611	879
Short "	228	217
Per cent. of wrappers in Crop	56	63
No. of pole-cured leaves in 1 pound long wrappers	62	58
short "	82	87
No. of seconds holds fire, long wrappers	7.6	7.6
short wrappers	11.1	9.7

The average annual yield per acre from dry fish has been much less than from cottonseed meal, by about 250 pounds, and the per cent. of wrappers in the crop has been considerably smaller (56 per cent. from dry fish, 63 per cent. from cottonseed meal). The crop from dry fish in 1893 was very small, one-half what it was in the next three years, and each successive crop has been larger than the one next preceding it, indicating perhaps that the nitrogen of fish is more slowly available, and that its effects are in consequence more lasting. The tobacco of the three crops on plot K (cottonseed meal), ranked 15th, 17th and 12th. The three corresponding crops on Z (fish), have ranked 12th, 3d and 11th. Hence for three successive years quite as good tobacco, though not as many pounds per acre, has been raised with dry fish and potash salts as with an equivalent quantity of cottonseed meal and potash salts.

STABLE MANURE AND TOBACCO STEMS.

Plots AA and BB were introduced into the experiment in 1893. In 1892 when the other plots were under tillage, these plots were uncultivated and were covered with a sparse growth of poverty grass and blackberry vines. Hence a *strict* comparison of these with the other plots cannot be made.

Plot AA has been dressed annually for four years with mixed yard manure at the rate of 10–12 cords per acre, estimated to supply about 111 pounds of nitrogen, 71 pounds of phosphoric acid and 149 pounds of potash. In 1893 and 1894 it also received 500 pounds per acre of Swift-Sure Superphosphate, containing 15 pounds of nitrogen, 72 pounds of phosphoric acid and 23 pounds of potash.

Plot BB has received in each of the four years 6000 pounds of tobacco stems, containing 111 pounds of nitrogen, 36 pounds of

* Four years, 1893–1896.

phosphoric acid and 486 pounds of potash. In 1893 and 1894 it likewise received 500 pounds of Swift-Sure Superphosphate.

The average results for the four years are given in Table VI, and for comparison the corresponding figures for plot A (average of the same four years).

TABLE VI.—STABLE MANURE COMPARED WITH COTTON SEED MEAL AND TOBACCO STEMS.

Fertilizer.	Plot A.* Cotton Seed Meal and Cotton Hull Ashes.	Plot AA.* Stable Manure.	Plot BB.* Tobacco Stems.
Average yearly yield of leaf-tobacco, pounds per acre	1585	1390	1654
Average yearly yield of long wrappers, pounds per acre	733	470	745
Average yearly yield of short wrappers, pounds per acre	219	211	231
Per cent. of wrappers in crop	60	49	59
No. of pole-cured leaves in 1 pound of long wrappers	63	64	67
No. of pole-cured leaves in 1 pound of short wrappers	85	74	85
No. of seconds holds fire, long wrappers	14	10	10
No. of seconds holds fire, short wrappers	15	12	12

The much smaller crops raised on stable manure are explained in part by the fact that the nitrogen of stable manure is far less readily available than that of either stems or cottonseed meal.

The views of growers in the Connecticut and Housatonic valleys regarding the value of stable manure are widely divergent. Some affirm that they would use nothing else if they could get enough stable manure; others would not use manure at all for this crop. It is certainly true that some of the finest broadleaf is grown on land dressed for the most part at least with manure. Many growers also give their lands a light dressing of yard manure every few years.

When no other fertilizers are used in connection with it the crop is rather light, at least for the first few years, till the land is well filled with the manure. The leaf is said to "lack finish" when pole-cured, *but after fermentation* it is said to have a "finish" superior to that raised on chemicals alone. We believe that an annual

* Average of *four* years.

dressing of manure will often pay well, supplementing it with a supply of more quickly available plant food in the form of fertilizer chemicals.

The successive crops from the plot AA, dressed with manure, ranked 13th, 17th and 1st.

Those from the plot BB (tobacco stems) ranked 16th, 21st, 19th, while the three corresponding crops on cottonseed meal ranked 23d, 5th and 14th.

Comparison of the Effects of Various Forms of Potash on the Quality of the Crop.

(Plots A, K, L, M, N, O, P,* Y.*)

All of the plots in this series were dressed each year with 105 pounds of nitrogen per acre, in form of cotton seed meal (about 1500 pounds per acre).

All were likewise dressed annually with 340 pounds per acre of potash, *but in different forms.* Thus A received cotton hull ashes; K, double sulphate of potash and magnesia; L, double sulphate of potash and magnesia, *with lime* at the rate of 300 pounds per acre; M, high grade sulphate of potash; N, high grade sulphate of potash and magnesia, *with lime* at the rate of 300 pounds per acre; O, carbonate of potash; P, double carbonate of potash and magnesia; and Y, wood ashes.

Plots A and Y received about 150 pounds of phosphoric acid annually per acre, chiefly in the ashes. The like quantity was supplied to the other plots in form of Cooper's bone.

The averages of the five years' course of experiments are given in Table VII. (See following page.)

The largest average yield of leaf tobacco (1771 pounds per acre) and of wrapper leaf (1151 pounds per acre), and the highest per cent. of wrapper leaf (65) in the crop, was taken from plot K, dressed with double sulphate of potash and magnesia as a source of potash.

The leaves were heavier (60 and 82 long and short wrapper leaves to the pound) than those from the other plots named, and their fire-holding capacity was less than that from any except those dressed with high grade sulphate of potash.

The quality of the wrappers, judged from the four crops already examined by the expert, was about the same as that of wrappers from plot A, where cotton hull ashes were used.

The addition of lime had little effect on the quality of leaf.

* Four years only.

TABLE VII.—COMPARISON OF THE EFFECTS OF VARIOUS FORMS OF POTASH AS TOBACCO FERTILIZERS.

	Plot A.	Plot K.	Plot L.	Plot M.	Plot N.	Plot O.	Plot P.*	Plot Y.*
Source of Potash.	Cotton Hull Ashes.	Double Sulphate of Potash and Magnesia.	Double Sulphate of Potash and Magnesia with Lime.	High Grade Sulphate of Potash.	High Grade Sulphate of Potash with Lime.	Carbonate of Potash.	Double Carbonate of Potash and Magnesia.	Wood Ashes.
Yield of Tobacco per acre	1615	1776	1664	1709	1690	1549	1416	1482
Long Wrappers	740	874	705	653	742	672	601	631
Short Wrappers	241	277	277	253	272	257	263	199
Per cent. of wrappers in crop	61	65	59	53	60	60	61	56
No. of pole-cured leaves in 1 lb. long wrappers	66	60	63	67	64	70	66	69
No. of pole-cured leaves in 1 lb. short wrappers	89	82	87	86	85	89	87	91
No. seconds holds fire, long wrappers	14	8	8	7	8	10	13	12
short wrappers	15	10	10	10	11	14	11.9	17
Relative rank	10–23–5–14	6–15–17–12	9–25–7–23	23–28–26–21	7–19–25–26	1–24–13–4	14–2–1	10–12–6

* Four years.

The plots dressed with high grade sulphate of potash with and without lime, M and N, bore a larger average crop than any except K, and rather more wrappers than most of the others. But the leaves held fire for a shorter time than those from the other plots, and the quality of the four crops already examined was poorer than that of any others in the series.

Plots O, P, Y, having as their source of potash, carbonate of potash, double carbonate of potash and magnesia and wood ashes respectively, bore lighter crops than the others in this series, but the average quality, judged from the four crops from O and three crops from P and Y, already examined, was the best in the whole experiment field.

Effects of Smaller Quantities of Potash in the Fertilizer.

Plots B and F in 1892 received a dressing of cotton hull ashes containing 340 pounds of potash per acre. B also received 140 pounds per acre of nitrogen in cottonseed meal; F received the same quantity of nitrogen in form of castor pomace.

For the next four years both plots received yearly like quantities of nitrogen and phosphoric acid, but plot F received only 150 pounds of actual potash per acre, while B received 340 pounds,—both in forms of cotton hull ashes.

The following table shows the average results of four years' test.

Table VIII.—Effects of Different Quantities of Potash.

Source of Fertilizer-Potash.	Plot B. Cotton Hull Ashes.	Plot F. Cotton Hull Ashes.
Amount of Fertilizer-Potash per acre, pounds........	340	150
Average yearly yield of leaf tobacco, pounds per acre	1501	1600
" " " long wrappers, " "	664	669
" " " short " " "	222	260
Per cent. of wrappers in crop....................	59	58
No. of pole-cured leaves in 1 pound of long wrappers	68	66
" " " 1 " short "	89	91
No. of seconds holds fire, long wrappers............	12	9
" " " short "	17	14

The results of four years' tests show a somewhat larger average crop on plot F, which received annually 150 pounds of potash, and over 40 pounds more annually of wrapper leaves. The number of pole-cured leaves to the pound was about the same on both plots, those from plot B holding fire a little longer.

There was little difference in the quality of the three crops which have been fermented.

In this experiment, therefore, about 900 pounds of cotton hull ashes per acre, or 190 pounds of potash, were annually put on the land in excess of the crop requirements.

As has been shown in previous reports, an average tobacco crop of 1800 pounds per acre, takes from the land not more than 150 pounds of potash in stalks and leaves. When land has been well fertilized for some years, it is probable that 150 pounds of water-soluble potash annually applied is enough to secure a full crop of tobacco.

An excess of potash, however, tends to neutralize the otherwise injurious effects of an excess of chlorides in the soil.

Tobacco Raised on Mixed Fertilizers supplied by Manufacturers.

Plot Q received per acre annually for five years, 2000 pounds of AA Superphosphate and 4000 pounds of Baker's Tobacco Manure, made and supplied by H. J. Baker & Bro. of New York. The two supplied 238 pounds of nitrogen, 452 pounds of phosphoric acid and 522 pounds of potash.

Plot R received per acre annually 2000 pounds of Stockbridge Tobacco Manure and 500 pounds of the same, used as a starter. The two supplied 154 pounds of nitrogen, 307 pounds of phosphoric acid and 278 pounds of potash.

Plot S received in 1892, 4000 pounds per acre of Bowker's Tobacco Manure. In 1893 and each succeeding year, 3000 pounds of Stockbridge Tobacco Manure and 500 pounds of Stockbridge Tobacco Starter were used, the two containing 209 pounds of nitrogen, 393 pounds of phosphoric acid and 396 pounds of potash.

The fertilizers for plots R and S were made and supplied by the Bowker Fertilizer Co. of Boston and New York.

Plot U received in 1892, per acre, 500 pounds lime, 500 pounds of Mapes' Tobacco Starter and 2600 pounds of Mapes' Wrapper Brand Tobacco Manure. In 1893 and the following years it received 600 pounds per acre of Mapes' Tobacco Starter and 2200 pounds of Mapes' Wrapper Brand Tobacco Manure, the two containing 158 pounds of nitrogen, 211 pounds of phosphoric acid and 278 pounds of potash.

Plot V received per acre in 1892, 500 pounds of lime, 500 pounds of Mapes' Tobacco Starter and 2600 pounds of Special Tobacco Manure. In 1893 it received 800 pounds of Starter and 2000 pounds of Mapes' Wrapper Brand Tobacco Manure. In 1894 and the following years it received 400 pounds of Starter and 2400 pounds of Wrapper Tobacco Manure. These supplied 163 pounds of nitrogen, 196 pounds of phosphoric acid and 294 pounds of potash.

Plot W received per acre in 1892, 500 pounds of lime, 500 pounds of Tobacco Starter and 2600 pounds of Special Tobacco Manure. In 1893 it received 1000 pounds of Starter and 1800 pounds of Wrapper Tobacco Manure. In 1894 and the following years it received 2400 pounds of Wrapper Tobacco Manure, supplying 151 pounds of nitrogen, 143 pounds of phosphoric acid and 280 pounds of potash.

The fertilizers for plots U, V and W were made and supplied by the Mapes' Formula and Peruvian Guano Co. of New York City.

Plot X received per acre in 1892, 6000 pounds of Sanderson's Tobacco Manure, and in 1893 and each of the following years it received 2000 pounds of the same brand of fertilizer, supplying 103 pounds of nitrogen, 281 pounds of phosphoric acid and 105 pounds of potash.

The fertilizers for this plot were made and supplied by L. Sanderson, New Haven.

The results of this series are given in the following table, and are submitted without further comment.

TABLE IX.—EFFECTS OF FERTILIZERS MADE AND SUPPLIED BY THE FIRMS NAMED.

Name of Manufacturer. Plot.	Baker. Q.	Bowker. R.	Bowker. S.	Mapes. U.	Mapes. V.	Mapes. W.	Sanderson X.
POLE-CURED CROP.							
Total crop, pounds per acre	1892	1614	1770	1991	1624	1600	1605
Long wrappers, " "	896	673	893	1039	796	764	765
Short " " "	252	247	273	256	226	228	240
Per cent. of wrappers	61	57	66	65	63	62	62
No. of long wrapper leaves per pound	58	64	61	59	61	63	61
No. of short wrapper leaves per pound	80	73	86	77	86	94	86
Holds fire, seconds, long wrappers	6.0	9.0	8.0	7.0	8.0	10.0	6.0
Holds fire, seconds, short wrappers	7.0	11.0	12.0	10.0	12.0	12.0	7.0

The relative rank of the tobacco from these plots, during the past four years, has been :—

Q	Baker's	15th,	20th,	29th,	24th
R	Bowker's	13th,	17th,	23d,	7th
S	"	11th,	7th,	22d,	8th
U	Mapes'	20th,	4th,	18th,	13th
V	"	24th,	11th,	24th,	3d
W	"	18th,	2d,	8th,	2d
X	Sanderson	21st,	27th,	9th,	27th

THE EFFECTS OF FERTILIZERS ON THE COMPOSITION OF WRAPPER LEAF TOBACCO.*

The analyses of leaf tobacco given in this paper were made on samples carefully drawn from the crops of plots each of which had an area of $\frac{1}{10}$ acre.

For at least four years, and in most cases, for five years, each of these plots had been dressed with fixed amounts of nitrogen, phosphoric acid and potash, which were the same each year and were derived from the same materials annually. The comparative quality of the crops from each plot has been determined annually after fermentation, by an expert.

The crops harvested in the last year of the experiment should show more clearly than those of a test made in a single year, the special effects which the several fertilizers have had on the chemical composition of the wrapper leaf as well as on its quality.†

The samples analyzed were taken from the following plots, and each will be referred to hereafter by the letter designating the plot on which it grew.

TABLE I.—DESCRIPTION OF PLOTS. CROP OF 1896.

Plot.	Fertilizers annually applied.	Quantity of Fertilizer Ingredients applied, lbs. per acre. Nitrogen.	Phos. Acid.	Potash.	Yield of Tobacco in 1896, lbs. per acre. Total.	Long Wraps.	Short Wraps.
P	Cotton seed meal, double carbonate potash and magnesia, bone	105	157	340	1255	525	265
D	Cotton seed meal, cotton hull ashes	210	195	340	1730	945	275
F	Linseed meal, cotton hull ashes, bone	105	143	150	1210	400	215
Y	Cotton seed meal, wood ashes	105	150	340	1390	635	200
AA	Horse manure	111	71	149	1375	650	160
O	Cotton seed meal, carbonate of potash, bone	105	157	340	1440	680	290
H	Castor pomace, cotton hull ashes	210	188	340	1775	940	275
L	Cotton seed meal, double sulphate potash and magnesia, bone	105	157	340	1515	645	225
BB	Tobacco stems	111	36	486	1585	830	295
M	Cotton seed meal, high grade sulphate of potash, bone	105	157	340	1540	645	250

* All the analyses given below were made by Messrs. Winton, Ogden and Mitchell. The results have been prepared for publication by the Vice-Director.

† The quality of the leaf is the sum of all those factors which the dealer and the cigar manufacturer regard in making their selection for purchase. Color,

The quality of the tobacco from these several plots cannot be learned till the autumn of 1897, after it has finished fermentation in the case. Lot P has ranked highest, on the average, for the previous years. D, F, Y, and AA have ranked next, all of them nearly alike, then follow O, H and L in the order given, then BB, while M has been decidedly the poorest of all. It is, however, quite possible that the comparative quality of the crops of 1896, from which these samples were taken, will differ from this average of the previous years.

The relative ranks of the pole-cured long and short wrappers of 1896, *as regards fire-holding capacity alone*, are as follows:

	1st.	2d.	3d.	4th.	5th.	6th.	7th.	8th.	9th.	10th.
Long wrappers,	Y	BB	D	P	O	F	L	AA	H	M
Short wrappers,	Y	F	O	D	P	BB	H	AA	M	L

Preparation of the Samples.

Each sample consisted of twelve hands, about fifteen wrappers to the hand, which were carefully drawn for the purpose, when the tobacco was sorted. These samples were dried for a short time at a low heat, not over 24° C., pulverized and kept in well-stoppered bottles for analysis.

Methods of Analysis.

Water, fiber, and ether extract were determined as recommended by the Association of Official Chemists.

Protein was calculated by subtracting from the total nitrogen those portions which were in form of nicotine and nitric acid, and multiplying the remainder by the factor 6.25.

Nicotine was determined by the method of Kissling, Fres. Zeitschr., XXI, p. 64.

Nitric Acid was extracted with 85 per cent. alcohol and determined by the method of Schulze-Tiemann, from the volume of nitric oxide gas evolved.

size, "grain," "finish," burn, size and kind of vein and stem, all go to make up the "quality" of which the dealer and cigar maker are the sole judges.

While it is true that good burning quality is essential to wrapper leaf tobacco, it is also true that to meet the present requirements of the market, other things are also essential which cannot be measured—like the burn—by any laboratory tests and can only be properly judged by one who is in touch with the trade in leaf tobacco.

Ash was determined in 100 grams of the dry tobacco by careful incineration of a weighed quantity of the tobacco in a platinum dish at a heat below redness. Owing partly to the presence of nitrates, as well as to the large amounts of lime and magnesia present, it is particularly easy to nearly free the ash of tobacco from coal at a low heat.

Nitrogen-free extract was determined as usual by difference.

The Tables of Analyses.

Tables II and III, given on page 325, show the composition of the air-dry leaves. The percentage of water ranges from 7.24 to 9.95. With this amount of water the leaves are very brittle and can be easily pulverized.

Considerably more sand adheres to the short than to the long wrappers because the former are nearer the base of the stalk. The average per cent. of adhering sand in the short wrappers is 6.52, and in the long wrappers 2.31 per cent.

Neither the moisture nor adhering sand are of any significance in studying the effects of the fertilizers, and the foregoing analyses have therefore been recalculated to a water-free and sand-free basis, as shown in Tables IV and V, page 326.

Tables VI and VII give the analyses of the crude ash of the several lots of tobacco, containing small quantities of hygroscopic water and of coal from imperfectly burned organic matters, and very considerable quantities of sand which adheres to the surface of the leaves, even after curing.

The crude ash also contains a comparatively large amount of carbonic acid, which is not found in the unburned leaf, but results from the destruction of the organic matter of the plant.

In Tables VIII and IX, these things, water, sand and carbonic acid, have been omitted and the analyses recalculated to "Pure Ash."

Analyses of Air-dry Leaf Tobacco.

Table II.—Long Wrappers. Unfermented Crops of 1896.

Plot.	P.	D.	F.	Y.	AA.	O.	H.	L.	BB.	M.
Water	9.76	9.25	9.95	8.53	9.01	8.23	9.30	9.01	7.75	8.16
Sand	2.34	2.72	1.75	2.53	1.98	2.44	2.45	2.35	1.56	3.05
Pure ash*	13.92	15.88	13.78	15.43	16.25	14.38	15.45	16.25	15.33	16.28
Ether extract	4.64	4.10	4.75	4.05	5.15	4.73	4.28	4.34	4.77	4.35
Fiber	12.16	11.21	12.29	11.83	13.15	12.28	11.38	12.24	12.35	12.55
Nicotine	3.22	2.75	2.96	2.64	2.38	2.85	2.90	2.56	3.32	2.50
Nitric acid	1.30	3.66	.54	1.27	.89	1.62	3.31	1.27	3.12	.54
Proteids, etc.†	17.13	16.25	15.75	15.69	15.19	17.00	16.69	16.06	17.19	16.06
Nitrogen-free extract	35.53	34.18	38.23	38.03	36.00	36.47	34.24	35.92	34.61	36.51
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Crude ash	20.76	24.09	20.24	23.73	22.15	22.91	23.05	23.52	23.10	25.26
Nitrogen as nicotine	.56	.48	.51	.46	.41	.49	.50	.44	.57	.43
Nitrogen as nitric acid	.34	.95	.14	.33	.23	.42	.86	.33	.81	.14
Nitrogen as proteids, etc.	2.74	2.60	2.52	2.51	2.43	2.72	2.67	2.57	2.75	2.57
Total nitrogen	3.64	4.03	3.17	3.30	3.07	3 63	4.03	3.34	4.13	3.14

* Free from sand, water, carbonic acid and charcoal.

† Total nitrogen, less nitrogen as nicotine and nitric acid, × 6.25.

Table III.—Short Wrappers. Unfermented Crops of 1896.

Plot.	P.	D.	F.	Y.	AA.	O.	H.	L.	BB.	M.
Water	9.65	8.35	9.41	9.22	9.11	7.24	8.19	8.14	8.33	7.58
Sand	6.72	7.57	4.71	5.04	6.22	6.94	7.96	6.97	5.01	8.04
Pure ash*	14.61	16.71	15.28	16.62	17.45	15.62	16.91	17.94	17.45	17.90
Ether extract	4.85	4.45	5.27	4.53	5.09	4.85	4.35	4.33	5.04	4.61
Fiber	10.69	10.12	12.37	11.27	11.98	11.00	10.20	10.68	11.21	10.95
Nicotine	2.93	2.26	2.33	1.98	1.99	2.40	2.16	2.15	2.18	1.89
Nitric acid	.56	2.08	.23	.60	.35	.71	2.91	.46	2.93	.27
Proteids, etc.†	10.87	11.50	11.31	11.25	11.00	11.62	12.44	10.87	12.37	11.62
Nitrogen-free extract	39.12	36.96	39.09	39.49	36 81	39.62	34.88	38.46	35.48	37.14
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Crude ash	26.47	30.85	25.29	28.67	28.51	30.11	30.63	30.58	29.77	32.95
Nitrogen as nicotine	.51	.39	.40	.34	.37	.41	.37	.37	.38	.33
Nitrogen as nitric acid	.15	.54	.06	.16	.09	.19	.76	.12	.76	.07
Nitrogen as proteids, etc.	1.74	1.84	1.81	1.80	1.76	1.86	1.99	1.74	1.98	1.86
Total nitrogen	2.40	2.77	2.27	2.30	2.19	2.46	3.12	2.23	3.12	2.26

* Free from sand, water, carbonic acid and charcoal.

† Total nitrogen, less nitrogen as nicotine and nitric acid, × 6.25.

ANALYSES OF LEAF-TOBACCO FREE FROM WATER AND SAND. (CALCULATED FROM TABLES II AND III.)

TABLE IV.—LONG WRAPPERS. UNFERMENTED CROPS OF 1896.

Plot.	P.	D.	F.	Y.	AA.	O.	H.	L.	BB.	M.
Pure ash*	15.84	18.04	15.60	17.35	18.26	16.10	17.51	18.33	16.90	18.34
Ether extract	5.28	4.66	5.38	4.55	5.78	5.29	4.85	4.90	5.26	4.90
Fiber	13.84	12.73	13.91	13.30	14.77	13.75	12.90	13.81	13.62	14.13
Nicotine	3.66	3.12	3.35	2.97	2.67	3.19	3.29	2.89	3.66	2.81
Nitric acid	1.48	4.16	.62	1.43	1.00	1.81	3.76	1.43	3.44	0.61
Proteids, etc.†	19.49	18.46	17.84	17.64	17.07	19.03	18.91	18.12	18.96	18.09
Nitrogen-free extract	40.41	38.83	43.30	42.76	40.45	40.83	38.78	40.52	38.16	41.12
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Nitrogen as nicotine	.64	.55	.58	.52	.46	.55	.57	.50	.63	.48
Nitrogen as nitric acid	.39	1.08	.16	.37	.26	.47	.97	.37	.89	.16
Nitrogen as proteids, etc.	3.11	2.95	2.85	2.82	2.73	3 04	3.03	2.90	3.03	2.89
Total nitrogen	4.14	4.58	3.59	3.71	3.45	4.06	4.57	3.77	4.55	3.53

* Free from sand, water, carbonic acid and charcoal.

† Total nitrogen, less nitrogen as nicotine and nitric acid, × 6.25.

TABLE V.—SHORT WRAPPERS. UNFERMENTED CROPS OF 1896.

Plot.	P.	D.	F.	Y.	AA.	O.	H.	L.	BB.	M.
Pure ash*	17.47	19.88	17.80	19.38	20.61	18.20	20.16	21.13	20.13	21.21
Ether extract	5.80	5.29	6.13	5.28	6.01	5.65	5.19	5.10	5.82	5.46
Fiber	12.78	12.03	14.40	13.14	14.15	12.82	12.16	12.58	12.93	12.98
Nicotine	3.50	2.69	2.71	2.31	2.36	2.80	2.58	2.53	2.52	2.24
Nitric acid	.67	2.47	.27	.70	.41	.83	3.47	.54	3.38	.32
Proteids, etc.†	13.00	13.67	13.16	13.12	12.99	13.54	14.84	12.80	14.27	13.77
Nitrogen-free extract	46.78	43.97	45.53	46.07	43.47	46.16	41.60	45.32	40.95	44.02
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Nitrogen as nicotine	.61	.46	.47	.40	.40	.48	.44	.44	.44	.39
Nitrogen as nitric acid	.18	.64	.07	.18	.11	.22	.90	.14	.87	.08
Nitrogen as proteids, etc.	2.08	2.19	2.10	2.10	2.08	2.16	2.38	2.04	2.29	2.21
Total nitrogen	2.87	3.29	2.64	2.68	2.59	2.86	3.72	2.62	3.60	2.68

* Free from sand, water, carbonic acid and charcoal.

† Total nitrogen, less nitrogen as nicotine and nitric acid, × 6.25.

Analyses of the Crude Ash of Leaf-Tobacco.

Table VI.—Long Wrappers. Unfermented Crops of 1896.

Plot.	P.	D.	F.	Y.	AA.	O.	H.	L.	BB.	M.
Water	1.18	.36	.37	.29	.59	.49	.51	.24	.96	.25
Carbonic acid	21.13	22.85	23.06	24.00	17.18	25.69	22.03	19.99	25.75	22.86
Charcoal	.35	.35	.34	.44	.56	.70	.46	.35	.45	.73
Sand	11.27	11.31	8.63	10.66	8.95	10.66	10.64	10.02	6.77	12.09
Silica	1.10	1.10	1.00	.76	.76	.90	1.02	.89	.72	.85
Potash	30.53	29.26	28.50	27.40	35.15	29.22	29.80	26.68	35.67	24.88
Soda	.72	.48	.58	.44	.29	.37	.54	.34	.32	.46
Lime	16.03	20.10	21.06	22.60	14.53	22.50	18.90	22.23	18.15	25.11
Magnesia	11.02	8.03	8.65	6.14	8.92	3.21	8 80	6.13	4.54	2.25
Oxide of iron and alumina	1.38	1.34	1.00	1.12	.84	1.26	1.23	1.23	.82	1.34
Phosphoric acid	2.55	2.23	2.30	2.12	2.50	2.24	2.28	2.73	1.98	3.07
Sulphuric acid	3.30	2.90	4.63	3.46	3.97	2.50	3.59	7.68	3.04	6.00
Chlorine	.56	.60	.44	1.27	8.26	.59	1.24	1.52	1.42	.62
	101.12	100.91	100.56	100.70	102.50	100.43	101.04	100.03	100.59	100.51
Oxygen equivalent to chlorine	.13	.13	.10	.28	1.86	.13	.38	.33	.31	.14
	100.99	100.78	100.46	100.42	100.64	100.30	100.66	99.70	100.28	100.37

Table VII.—Short Wrappers. Unfermented Crops of 1896.

Plot.	P.	D.	F.	Y.	AA.	O.	H.	L.	BB.	M.
Water	2.00	.45	.60	.45	.53	.58	.82	.41	.62	.42
Carbonic acid	17.27	19.59	20.18	22.84	15.31	21.88	17.61	17.96	23.14	19.40
Charcoal	1.23	1.18	.93	1.26	1.56	1.87	.67	.59	.86	1.16
Sand	25.40	24.53	18.62	17.57	21.83	23.05	25.99	22.79	16.82	24.43
Silica	1.33	1.50	1.46	.99	1.10	1.40	1.79	1.11	1.15	1.28
Potash	25.57	21.82	24.09	24.02	26.14	23.31	24.56	21.01	30.13	19.89
Soda	.42	.64	.81	.72	.40	.40	.57	.42	.64	.49
Lime	10.35	18.45	18.75	21.10	14.35	19.78	14.13	19.75	17.52	21.95
Magnesia	12.34	6.81	8.72	5.33	8.37	2.68	8.90	5.87	4.10	2.56
Oxide of iron and alumina	1.42	1.38	1.34	1.38	1.71	1.38	1.14	1.60	1.36	1.14
Phosphoric acid	1.57	1.57	1.64	1.41	1.82	1.36	1.44	1.76	1.12	2.05
Sulphuric acid	1.97	1.77	3.40	2.59	2.76	1.36	2.24	6.59	2.02	4.74
Chlorine	.27	.26	.25	.58	5.88	.29	.57	.69	.73	.28
	101.14	99.95	100.79	100.24	101.76	99.34	100.43	100.55	100.21	99.79
Oxygen equivalent to chlorine	.06	.05	.05	.13	1.32	.06	.12	.15	.16	.06
	101.08	99.90	100.74	100.11	100.44	99.28	100.31	100.40	100.05	99.73

Analyses of the Pure Ash of Leaf-Tobacco.

Table VIII.—Long Wrappers. Unfermented Crops of 1896.

Plot.	P.	D.	F.	Y.	AA.	O.	H.	L.	BB.	M.
Silica	1.64	1.67	1.47	1.17	1.04	1.43	1.52	1.29	1.09	1.32
Potash	45.54	44.40	41.88	42.14	47.91	46.56	44.46	38.62	53.76	38.61
Soda	1.07	.73	.85	.68	.40	.59	.81	.49	.48	.71
Lime	23.89	30.50	30.95	34.76	19.80	35.85	28.20	32.17	27.35	38.98
Magnesia	16.43	12.18	12.70	9.44	12.16	5.12	13.13	8.87	6.84	3.49
Oxide of iron and alumina	2 06	2.03	1.47	1.72	1.14	2.01	1.84	1.78	1.24	2.08
Phosphoric acid	3.80	3.38	3.38	3.26	3.41	3.57	3.40	3.95	2.98	4.76
Sulphuric acid	4.92	4.40	6.80	5.32	5.41	4.14	5.35	11.11	4.58	9.31
Chlorine	.84	.91	.65	1.95	11.26	.94	1.85	2.20	2.14	.96
	100.19	100.20	100.15	100.44	102.53	100.21	100.56	100.48	100.46	100.22
Oxygen equivalent to chlorine	.19	.20	.15	.44	2.53	.21	.56	.48	.46	.22
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table IX.—Short Wrappers. Unfermented Crops of 1896.

Plot.	P.	D.	F.	Y.	AA.	O.	H.	L.	BB.	M.
Silica	2.41	2.77	2.41	1.70	1.80	2.69	3.24	1.89	1.95	2.36
Potash	46.34	40.29	39.88	41.43	42.70	44.92	44.48	35.82	51.41	36.62
Soda	.76	1.18	1.34	1.24	.65	.77	1.03	.72	1.09	.90
Lime	18.76	34.07	31.04	36.39	23.45	38.11	25.59	33.68	29.90	40.41
Magnesia	22.37	12.58	14.44	9.19	13.68	5.16	16.12	10.00	6.99	4.71
Oxide of iron and alumina	2.57	2.55	2.22	2.37	2.79	2.66	2.06	2.73	2.32	2.10
Phosphoric acid	2 84	2.90	2.71	2.43	2.97	2.62	2.61	3.00	1.91	3.77
Sulphuric acid	3.57	3.27	5.63	4.47	4.51	2.62	4.06	11.23	3.45	8.72
Chlorine	.49	.48	.41	1.00	9.61	.56	1.03	1.18	1.25	.52
	100.11	100.09	100.08	100.22	102.16	100.11	100.22	100.25	100.27	100.11
Oxygen equivalent to chlorine	.11	.09	.08	.22	2.16	.11	.22	.25	.27	.11
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Discussion of the Tables of Analyses.

We are here concerned chiefly with the effects of fertilizers on the chemical composition of the crops. The relation between the chemical composition and the quality of the wrapper leaf of 1896, cannot be fully considered until the samples have been fermented and graded according to their quality. Tables IV and V show that the short wrappers have about two per cent. more of ash or mineral matter than the long wrappers, half a per cent. more of ether extract (fat, wax, chlorophyl, etc.), and about four per cent. more of "nitrogen-free extract" (sugar, starch, gum, etc.).

On the other hand they have less fiber by about 0.7 per cent., less nicotine by 0.5 per cent., less nitric acid by .67 per cent., and less protein by 3.85 per cent.

The explanation of these differences is in the facts that the short wrappers are rather more mature at harvest than the long wrappers, they are smaller and have perhaps already returned to the stalk and to the upper leaves a portion of their substance, particularly nitrogenous matter, which is always most abundant, proportionally, in rapidly growing parts,—and in the seed.

There appear to be no differences in the percentages of ether extract, fiber and nitrogen-free extract which can be connected with differences in the fertilizers used.

There is a range of 3.7 per cent. in the amount of pure ash of the short wrappers and of 2.7 per cent. in the ash of the long wrappers.

The wrappers from M, fertilized with high grade sulphate of potash, Cooper's bone and cottonseed meal, and which were decidedly inferior to the other lots in quality in the three years previous, have the largest per cent. of ash.

Most striking are the percentages of nitric acid. A small amount of nitrate is almost always found in wrapper-leaf tobacco. The wrappers from plots D and H, which were annually dressed with twice as much fertilizer-nitrogen as the others, and also those from plot BB, which was dressed with 111 pounds of fertilizer-nitrogen in form of tobacco stems, contained very much more nitrate than any other of the tobaccos.

The long wrappers from the three plots named contained 4.16, 3.76 and 3.44 per cent. respectively, while the highest per cent. in any other lot examined was 1.81. The short wrappers from the same plots contained 2.47, 3.47 and 3.38 per cent., while the highest per cent. in any other lot was .83.

Where available nitrogen is present in considerable excess of the crop requirements, as it undoubtedly was on plots D and H, it is to be expected that more nitrogen may pass into the plant than is needed for its development and may be deposited in the tissues as nitrate of potash.

The high percentage of nitrates in BB cannot be thus explained. When the normal development of the plant is hindered by drought or other unfavorable influence, nitrogen may be taken up from the soil as nitrates which the plant is unable to utilize for the production of proteids or other nitrogenous organic matters. There is, however, no other indication that the tobacco grown on this plot suffered from any unfavorable influences other than affected all the rest of the field.

The percentage of protein in the long wrappers ranges from 17.1 to 19.5. The three plots, D, H and BB, which had the highest per cent. of nitrates, are surpassed by only two lots, O and P, in percentage of protein.

The percentage of protein in the short wrappers ranges from 10.09 to 12.4, and here, too, the three lots, D, H and BB, show a higher percentage of protein than most of the others.

The highest percentage of nicotine is found in both long and short wrappers from plot P, dressed with double carbonate of potash and magnesia, cotton seed meal and bone. Tobacco from this plot has been of better average quality, in the three years 1893, '94 and '95, than that from any other of those represented in this table.

The effect of fertilizers on the composition of the ash, as shown in Tables VIII and IX, is very marked.

There are no striking differences in the composition of the ash of the long and short wrappers. The ash of the short wrappers contains a somewhat larger percentage of silica, soda, lime, magnesia, and oxide of iron than the long wrappers, while the latter contain correspondingly more potash, phosphoric acid, sulphuric acid and chlorine than the short wrappers.

These differences are fully explained by the fact that the short wrappers were more mature than the long wrappers when harvested.

In the following paragraphs reference is made to the long wrappers only, except where the short wrappers are specially mentioned.

1. Potash ranges from 53.76 to 38.61 per cent. The per cent.

is highest on tobacco from plot BB, which received annually most fertilizer-potash (in form of tobacco stems). It is least in tobacco from plots L and M, both of which received 340 pounds of fertilizer-potash annually in form of sulphate, M as high grade sulphate, L as low grade sulphate. The per cent. of potash in lots L and M is even less than in lots AA and F, which received only 150 pounds of fertilizer-potash yearly, but in form of manure or of cotton hull ashes.

It appears, therefore, that from equal quantities of fertilizer-potash, added presumably quite in excess of crop requirements, the tobacco crop took up much less from forms containing sulphate than from those containing potash as carbonate, plots O, P, D, F and Y.

The tobacco which held fire longest was lot Y, in which the per cent. of potash was less than the average. The per cent. of lime and magnesia taken together is, however, larger than in any other lot.

Next in fire-holding capacity among the long wrappers is BB, which contains more potash than any others, while the per cent. of lime and magnesia is smaller than any others. Lot D comes next, in which the per cent. of potash is about the average, while the sum of the per cents. of lime and magnesia is higher than any except Y and F.

Lot M had the poorest fire-holding capacity. It contained less potash than any other lot, more lime and magnesia than most, more phosphoric acid than any and more sulphuric acid than any except L.

In general the same things hold true of the short wrappers. The relative fire-holding capacity of the short wrappers is, however, not the same. Lot Y held fire longest, followed by F, O and D in the order named. Lot L had the least fire-holding capacity and M next.

2. The percentage of lime in the long wrappers ranges from 19.80 to 38.98. It is least in lot AA (stable manure), next in lot P (bone, carbonate of potash and magnesia and cotton seed meal), next in BB (stems).

Lot M, which received high grade sulphate of potash with lime and cotton seed meal, contained most lime, and lot O came next in this respect.

Lots M and O, which have most lime, have least magnesia, while those lots having least lime have relatively the most mag-

nesia. The percentage of lime in the pure ash of the long wrappers ranges from 19.8 to 38.98 per cent., and magnesia from 3.49 to 16.43 per cent. But the percentages of lime and magnesia, *taken together*, show a much narrower range, viz. from 31.9 to 43.65.

Plot P received annually a dressing of magnesia amounting to 300 pounds or more, plot Y received annually over 200 pounds, plot L 170 pounds, plots H and D about 120 pounds and plot F one-half that amount.

The effects of these applications appear in the ash analyses. Lot P contains most magnesia, lots H, F and D rank next in this regard, followed by Y.

Lots P, Y, F and D, which contained comparatively large percentage amounts of magnesia in the ash, have been among the best tobaccos, as regards quality, in the previous years.

These statements regarding the long wrappers are substantially correct, also, for the short wrappers.

It is noteworthy that the short wrappers of lot P, which in previous years have been of better quality than any other of the lots here discussed, contained more magnesia than lime in the ash.

3. The percentage amounts of sulphuric acid in the ash of lots L and M, from the plots dressed with sulphates of potash, are very much larger than any others, as was to be expected.

4. Lot AA, from the plot dressed with stable manure, contains a very high percentage of chlorine, 11.26, five times as much as any other lot in the series. Of the other lots, L, BB, Y and H contain over one per cent.

Double sulphate of potash and magnesia (L), tobacco stems (BB), and wood ashes (Y), all contain small amounts of chlorine, which, in addition to what chlorine is always in the soil and the rain, explains the percentages found, none of which are of special significance as regards their effect on the quality of the tobacco, except that in AA.

The observations here made are summarized as follows:—

1. The analyses represent the cumulative effects on the composition of the tobacco leaf of fertilizers applied for four and five years in succession.

2. The short wrappers have a somewhat larger percentage of ash, ether-extract and nitrogen-free extract than the long wrappers and correspondingly less fiber, nicotine, nitric acid and protein.

Of ash ingredients the short wrappers contain a somewhat larger percentage of silica, soda, lime, magnesia and oxide of iron, and a correspondingly smaller percentage of potash, phosphoric acid, sulphuric acid and chlorine.

3. There are no differences in the percentages of ether-extract, fiber and nitrogen-free extract traceable to the different fertilizers used.

Where fertilizer-nitrogen was applied in large excess of the probable crop requirements, a much larger percentage of nitrates was found in the leaf, amounting in one case to 3.78 per cent. of nitric acid (N_2O_5), than where smaller quantities of fertilizer-nitrogen were applied.

The percentages of protein and of nicotine were also above the average in tobacco to which the larger quantities of fertilizer-nitrogen had been applied.

4. The fertilizers used have had striking effects on the composition of the ash.

a. The largest percentage of potash was in tobacco to which most fertilizer-potash had been applied.

The percentage of potash is least in the ash of tobacco from the plots dressed with potash in form of sulphate. The percentage of potash in the ash of the tobacco from those plots is also less than it is in the ash of tobacco from plots which were dressed with the same, or even half the same quantity of fertilizer-potash in form of carbonate.

b. The tobacco dressed with high-grade sulphate of potash and the ash of which contained a smaller per cent. of potash than any other lot, contains on the other hand the highest per cent. of lime, and the tobacco dressed with the double sulphate of potash and magnesia also contains a relatively high per cent. of lime.

c. In general the tobaccos which have most lime have least magnesia, and vice versa. Comparatively large percentages of magnesia are found in the lots of tobacco which were raised on plots dressed with fertilizers containing much magnesia. In the short wrappers of a single plot, P, the percentage of magnesia was larger than that of lime.

The quality of the leaf has not been damaged in previous years by these large quantities of magnesia. Lots P, Y, F and D, which have large percentage amounts of magnesia, have heretofore been among the best tobaccos as regards quality of leaf.

d. The percentage of sulphuric acid in the leaf is very much larger when sulphates are used in the fertilizer.

It is believed that these large amounts of sulphuric acid impair the burning quality of the leaf, and in this experiment the "burn" of tobacco from the plot which was dressed with high-grade sulphate, has been very unsatisfactory.

e. The ash of tobacco from the plot dressed with stable manure contains five times as much chlorine as the ash from any other lot in the series.

AMOUNT OF NITROGEN, PHOSPHORIC ACID AND POTASH IN PEAS AND BEANS.

Samples of Peas of a wrinkled variety and of field Beans were sent to the Station by E. E. Burwell, New Haven, with a statement of the yield per acre, and an inquiry as to how much plant food each crop took from an acre in the seed alone.

The analyses were as follows:

	Peas.	*Beans.*
	5237	**5235**
Nitrogen	4.27 per cent.	3.75 per cent.
Phosphoric acid	1.07 "	.90 "
Potash	1.13 "	1.47 "
Yield per acre	20 bushels.	25 bushels.
Equivalent to	1,120 pounds.	1,500 pounds.
Containing per acre—Nitrogen	47.8 pounds.	56.2 pounds.
Phosphoric acid	13.1 "	13.5 "
Potash	12.7 "	22.0 "

The crop of beans took from an acre about the same amount of phosphoric acid as the peas, but 9 pounds more each of nitrogen and of potash.

OBSERVATIONS ON THE GROWTH OF MAIZE CONTINUOUSLY ON THE SAME LAND FOR NINE YEARS.*

The plan of this experiment and the results obtained in previous years are given in detail in the Nineteenth Report of this Station, for 1895, pp. 216–225.

The results of the experiment in 1896 are here placed on record without discussion, which is reserved.

Gross Yield of the Plots in 1896.

Table I presents the gross weight of the kernels, cobs and stover harvested on each plot. Inasmuch as the kernels were air-dried on the cob, the weight of the latter in the field-cured condition could not be taken. Hence the weight of the kernels given in the table is slightly too high and that of the cobs slightly too low. But the error is small.

Table I.—Gross Yield of the Plots in Pounds per Acre. 1896.

	Plot A. Cow Manure.	Plot B. Hog Manure.	Plot C. Chemicals.	Plot D. No Fertilizer.
Kernels	5478.5	5975.5	4210.0	672.0
Cobs	664.0	737.0	530.0	78.0
Stover	11,557.5	10,957.5	6750.0	3900.0
Total	17,700.0	17,670.0	11,490.0	4650.0

Since these crops contain a large and variable quantity of water, a strict comparison of the yields can only be made on the dry matter.

This appears in Table II.

Table II.—Dry Matter of the Crops, Pounds per Acre. 1896.

	In Kernels.	In Cobs.	In Stover.	Total.
Plot A, cow manure	3338.2	593.0	6484.6	10,415.8
Plot B, hog manure	3652.3	658.1	5260.3	9570.7
Plot C, fertilizer-chemicals	2372.4	473.3	3516.6	6362.3
Plot D, no fertilizer	342.1	69.7	1670.9	2082.7

The percentage of water-free kernels, cobs and stover on the several plots, appears in the following table :

* The analyses given in this paper have been made by Messrs. Winton, Ogden and Mitchell, chemists of this Station. This paper has been prepared for publication by the Vice-Director.

TABLE IIA.—PERCENTAGE OF WATER-FREE KERNELS, COBS AND STOVER, IN THE CROPS. AVERAGE OF SEVEN YEARS.

	Plot A.	Plot B.	Plot C.	Plot D.
Kernels	38.1	41.3	41.4	29.5
Cobs	6.7	7.4	8.2	5.5
Stover	55.2	51.3	50.4	65.0
	100.00	100.00	100.0	100.0

The relative yields of dry matter from these plots for the last seven years are given in Table III, the yield of plot A being marked in each case as 100.

TABLE III.—RELATIVE YIELD OF DRY MATTER FROM PLOTS A, B, C, D FOR SEVEN YEARS.

	Plot A.	B.	C.	D.
1890	100	104.7	89.5	73.5
1891	100	92.9	82.0	65.9
1892	100	114.6	98.3	48.9
1893	100	95.1	73.2	43.1
1894	100	95.6	96.9	66.9
1895	100	108.2	72.6	38.4
1896	100	91.9	61.1	20.0
Average	100	100.4	81.8	51.0

If the yield from each plot in 1890 is called 100, the comparative yields for the following years will be as represented in Table IIIA.

TABLE IIIA.—RELATIVE YIELD OF DRY MATTER IN THE SEVEN YEARS, 1890 TO 1896.

	Plot A.	Plot B.	Plot C.	Plot D.
1890	100	100	100	100
1891	96	81	83	81
1892	79	87	88	53
1893	58	53	48	34
1894	44	41	48	41
1895	82	85	67	43
1896	116	101	79	31

YIELD OF EACH FOOD INGREDIENT.

In Table IV are given the quantities, in pounds per acre, of each food ingredient harvested from the four plots in 1896.

The cobs were not analyzed, but as their amount is relatively very small, the average composition of cobs as determined in other analyses is used for the calculation.

TABLE IV.—YIELD OF FOOD INGREDIENTS IN POUNDS PER ACRE. 1896.

	Plot A.				Plot B.				Plot C.				Plot D.			
	Kernels.	Cob.	Stover.	Total.	Kernels.	Cob.	Stover.	Total.	Kernels.	Cob.	Stover.	Total.	Kernels.	Cob.	Stover.	Total.
Water	2138.8	71.0	5072.6	7282.4	2324.5	78.9	5696.8	8100.2	1838.1	56.7	3233.3	5128.1	329.9	8.3	2229.3	2567.5
Ash	31.2	9.3	404.5	445.0	37.0	10.3	303.5	350.8	12.2	7.4	188.3	207.9	2.0	1.1	84.6	87.7
Albuminoids	347.3	15.9	399.9	763.1	411.0	17.7	356.1	784.8	244.6	12.7	247.7	505.0	31.0	1.9	99.8	132.7
Fiber	45.5	199.9	2260.6	2506.0	55.0	221.8	1775.1	2051.9	34.1	159.5	1184.0	1377.6	4.9	23.5	496.9	525.3
Nitrogen-free extract	2740.4	364.6	3341.3	6446.3	2955.0	404.6	2765.7	6125.3	1961.9	291.0	1854.2	4107.1	287.5	42.8	966.4	1296.7
Fat	175.3	3.3	78 6	257.2	193.0	3.7	60.3	257.0	119.1	2.7	42.5	164.3	16.7	.4	23.0	40.1
	5478.5	664.0	11,557.5	17,700.0	5975.5	737.0	10,957.5	17,670.0	4210.0	530.0	6750.0	11,490.0	672.0	78.0	3900.0	4650.0

Table V shows the composition of the crops on the four plots, A, B, C and D, for the year 1896.

Table VI exhibits the striking differences in the percentage composition of the crops on the four plots calculated from the average of six years.

The crops, both of kernels and stalks, on A and B, which have been very heavily dressed each year, the one with cow manure, the other with hog manure, are practically identical as regards chemical composition.

The kernels of the crop on C, which receives each year a liberal dressing of fertilizer chemicals, 1500 pounds to the acre, contains in the kernels somewhat less ash or mineral matter and fat, and half a per cent. less of proteids, etc., than the crops on A and B, with correspondingly more nitrogen-free extract. Similar differences are found in the composition of the stalks.

The kernels in the crop on D, to which no fertilizer or manure has been applied since 1889, have 2.0 per cent. less proteids than that of plots A and B, somewhat less ash and fat, but more fiber and nitrogen-free extract.

TABLE V.—COMPOSITION, PER CENT., OF FIELD-CURED MAIZE, KERNELS AND STOVER FROM PLOTS A, B, C, D. 1896.

	Analyses of Field-cured Maize.						Calculated Water-free.				
	Water.	Ash.	Albuminoids.	Fiber.	Nitrogen-free Extract.	Fat.	Ash.	Albuminoids.	Fiber.	Nitrogen-free Extract.	Fat.
KERNELS.											
Plot A	39.04	.57	6.34	.83	50.02	3.20	.93	10.38	1.35	82.07	5.27
Plot B	38.90	.62	6.88	.92	49.45	3.23	1.04	11.26	1.50	80.91	5.29
Plot C	43.66	.29	5.81	.81	46.60	2.83	.52	10.32	1.44	82.69	5.03
Plot D	49.09	.30	4.61	.73	42.79	2.48	.59	9.05	1.44	84.05	4.87
STOVER.											
Plot A	43.89	3.50	3.46	19.56	28.91	.68	6.25	6.16	34.87	51.51	1.21
Plot B	51.99	2.77	3.25	16.20	25.24	.55	5.78	6.76	33.75	52.57	1.14
Plot C	47.90	2.79	3.67	17.54	27.47	.63	5.36	7.04	33.67	52.72	1.21
Plot D	57.16	2.17	2.56	12.74	24.78	.59	5.07	5.97	29.74	57 83	1.39

TABLE VI.—AVERAGE COMPOSITION OF THE DRY MATTER OF KERNELS AND STOVER OF CROPS OF 1890, 1891, 1892, 1893, 1894, 1895 AND 1896.

	Ash.	Albuminoids.	Fiber.	Nitrogen-free Extract.	Fat.
		KERNELS.			
Plot A........	1.29	11.34	1.68	80.44	5.25
" B........	1.42	11.56	1.62	80.13	5.27
" C........	1.17	10.97	1.76	81.02	5.08
" D........	1.17	9.33	1.82	82.83	4.85
		STOVER.			
Plot A........	6.54	6.65	33.40	52.01	1.40
" B........	6.66	6.65	33.68	51.60	1.41
" C........	5.80	6.41	34.13	52.30	1.36
" D........	5.19	5.43	32.96	54.99	1.43

To complete the data regarding this experiment two other tables are presented.

Table VII gives the quantities of nitrogen, phosphoric acid and potash which were added in the manure or fertilizers and remained in the crops of 1896.

It also gives the amounts of those fertilizing materials which have been added to the soil capital (+) or withdrawn (−) in the eight years during which accurate account has been kept.

Table VIII gives the record of the crops on the four plots for the whole period covered by the experiment and also the percentage composition of the several crops. The "bushels of shelled corn" given in this table have been calculated by adding 20 per cent. to the weight of the water-free kernels and dividing the sum by 50.

TABLE VII.—ENRICHMENT OR IMPOVERISHMENT OF SOIL BY NINE YEARS' MANURING AND CROPPING WITH INDIAN CORN. POUNDS PER ACRE.

	Cow Manure. Plot A.			Hog Manure Plot B.			Fertilizer Chemicals. Plot C.			No Fertilizer. Plot D.		
	Nitrogen.	Phos. acid.	Potash.	Nitrogen.	Phos. acid.	Potash.	Nitrogen.	Phos. acid.	Potash.	Nitrogen.	Phos. acid.	Potash.
After seven years' cropping	+1117.9	+788.1	+799.1	+1879.8	+3446.0	+63.9	+520.2	+971.6	+177.4	−316.6	+53.8	−66.0
Applied in 1896	286.3	136.4	204.5	419.9	586.5	72.4	172.0	162.0	69.0	00.0	00.00	00.0
Taken off in Crop of 1896	122.1	31.7	147.8	125.6	45.5	143.1	80.8	22.2	75.6	21.2	7.4	6.6
Excess (+) or Deficiency (−) after nine years' cropping	+1282.1	+892.8	+155.8	+2174.1	+3987.0	−6 8	+611.4	+1111.4	+170.8	−337.8	+46.4	−72.6

TABLE VIII.—YIELD OF DRY MATTER AND "SHELLED CORN" PER ACRE FOR NINE YEARS AND COMPOSITION OF DRY MATTER.

	Year.	Distance of Planting.	Pounds of Dry Matter per Acre.	Bushels of Shelled Corn.	Percentage Composition of Dry Matter: Ash.	Proteids, etc.	Fiber.	Nitrogen-free Extract.	Fat.
Fertilized alike with chemicals	1888	Stalks 12 inches apart.	7350	75	3.3	7.8	19.4	66.1	3.4
	1888	" 6 " "	7980						
	1889	" 12 " "	6144	60	3.5	6.1	21.7	69.7	3.0
	1889	" 6 " "	6353						
Cow Manure	1890A	" 10 " "	9014	91	4.0	7.9	19.8	65.7	2.6
Hog Manure	1890B	" 10 " "	9436	97	4.2	8.0	19.6	65.5	2.7
Fertilizer Chemicals	1890C	" 10 " "	8070	87	3.9	8.0	21.2	64.4	2.5
No Manure or Fertilizer	1890D	" 10 " "	6626	51	3.8	6.2	20.7	66.7	2.6
Cow Manure	1891A	" 12 " "	8176	103	3.2	7.5	15.5	70.2	3.6
Hog Manure	1891B	" 12 " "	7599	88	3.3	7.6	16.2	69.3	3.6
Fertilizer Chemicals	1891C	" 12 " "	6708	70	3.2	6.4	18.5	68.8	3.1
No Manure or Fertilizer	1891D	" 12 " "	5391	60	3.1	6.0	17.4	70.2	3.3
Cow Manure	1892A	" 12 " "	7181	72	4.0	8.2	19.6	65.1	3.1
Hog Manure	1892B	" 12 " "	8233	84	4.0	8.8	19.3	64.8	3.1
Fertilizer Chemicals	1892C	" 12 " "	7062	86	3.2	8.3	17.5	67.8	3.2
No Manure or Fertilizer	1892D	" 12 " "	3509	38	3.3	7.7	18.8	67.2	3.0
Cow Manure	1893A	" 12 " "	5277	53	4.3	8.8	20.8	63.3	2.8
Hog Manure	1893B	" 12 " "	5020	52	3.8	8.4	21.1	63.9	2.8
Fertilizer Chemicals	1893C	" 12 " "	3858	37	3.8	9.0	21.6	63.0	2.6
No Manure or Fertilizer	1893D	" 12 " "	2277	18	4.6	8.2	22.5	62.4	2.3
Cow Manure	1894A	" 12 " "	4021	42	4.3	9.0	18.8	64.5	3.4
Hog Manure	1894B	" 12 " "	3845	40	4.2	9.2	18.1	65.2	3.3
Fertilizer Chemicals	1894C	" 12 " "	3898	42	4.3	8.7	18.2	65.5	3.3
No Manure or Fertilizer	1894D	" 12 " "	2691	27	3.6	7.2	20.0	66.2	3.0
Cow Manure	1895A	" 12 " "	7408	75	3.8	8.7	20.0	64.6	2.9
Hog Manure	1895B	" 12 " "	8013	80	4.4	8.7	20.7	63.2	3.0
Fertilizer Chemicals	1895C	" 12 " "	5375	58	3.1	8.2	20.1	65.6	3.0
No Manure or Fertilizer	1895D	" 12 " "	2842	28	2.9	6.4	20.7	67.3	2.7
Cow Manure	1896A	" 12 " "	10416	80	4.3	7.3	24.7	61.2	2.5
Hog Manure	1896B	" 12 " "	9571	88	3.7	8.2	21.4	64.0	2.7
Fertilizer Chemicals	1896C	" 12 " "	6362	57	3.3	7.9	21.6	64.6	2.6
No Manure or Fertilizer	1896D	" 12 " "	2083	8	4.2	6.4	25.2	62.3	1.9

THE PROTEIDS OF LUPIN SEEDS.

By Thomas B. Osborne and George F. Campbell.

The lupin is a leguminous plant little known in this country except as a garden ornament. The yellow lupin (*Lupinus luteus*) and the blue lupin (*Lupinus angustifolius*), both native to Mediterranean regions, have long been cultivated in Europe because of their ability to grow luxuriantly on sandy or gravelly soils, and by their help large areas of poor, "worn out" land have been reclaimed and made agriculturally profitable, as these plants furnish abundant fodder and by the decay of their deeply penetrating roots, and especially when plowed under green, they rapidly impregnate the soil with humus and render it productive for other crops.

Ritthausen (Jour. f. Prakt. Chem., **103**, 78; the same, New Series, **24**, 222, and **26**, 422, and Die Eiweisskörper, etc., Bonn, 1872), first studied and described under the name *conglutin* the characteristic proteid of the lupin seed. He found that the yellow and blue lupin both yielded conglutin scarcely distinguishable in properties and only differing in composition as respects sulphur, of which his preparations from the yellow lupin contained 1 per cent. and those from the blue lupin but 0.5 per cent. Ritthausen also analyzed preparations which, from their composition, he concluded to be legumin. He stated that both legumin and conglutin are extracted from lupin seeds by salt solutions as well as by dilute alkali, and that the two proteids can be separated from each other by dissolving in alkali, then precipitating with an acid and finally treating with salt solution. On neutralizing these alkali solutions conglutin retains while legumin loses its solubility in saline solutions.

By extracting with five per cent. sodium chloride brine Ritthausen obtained two preparations from yellow lupin having the composition given under **1** and **2**; by dissolving **2** in potash water and reprecipitating, **3** was prepared; the blue lupin by extracting with salt solution yielded **4**.

Conglutin, Ritthausen.

	Yellow Lupin.			Blue Lupin.
	1	2	3	4
Carbon	50.40	50.58	50.26	50.39
Hydrogen	7.00	7.06	6.89	6.94
Nitrogen	18.34	18.04	18.28	18.22
Sulphur } Oxygen }	24.26	24.32	1.01	0.49
			23.56	23.96
	100.00	100.00	100.00	100.00

The proteid rendered insoluble in salt solution by previous precipitation from an alkaline liquid, by acetic acid, he found to have the following composition, these figures being the average of five quite closely agreeing analyses :

LEGUMIN, RITTHAUSEN.

Carbon	51.36
Hydrogen	6.97
Nitrogen	17.50
Sulphur	0.59
Oxygen	23.58
	100.00

Palladin (Zeit. f. Biol., **31**, 191) has recently described the properties of "vitellin" contained in seeds of the yellow lupin. In many details the results of his work do not agree with ours, but as he admits that the "vitellin" which he examined was always somewhat impure, it is unnecessary to review his statements here.

YELLOW LUPIN.

We find that seeds of the yellow lupin contain a small quantity of proteid that is soluble in pure water, a large quantity soluble in salt solutions, a small amount soluble in potash-water, and a little nitrogenous matter, presumably proteid, which cannot be extracted by these solvents.

To determine the proportions of these proteids, very finely ground yellow lupin meal was first completely extracted with warm alcohol of .868 sp. gr. in order to remove as far as possible the amides and alkaloids which occur in considerable quantities in this seed. The air dry meal before exhaustion with alcohol contained 8.16 per cent. of nitrogen. Alcohol removed 11.0 per cent. of the meal and gave a residue containing 8.49 per cent. of nitrogen, showing that 0.60 per cent. of nitrogen calculated on the original meal had been removed. The original meal accordingly contained 7.56 per cent. of nitrogen in the form of compounds insoluble in alcohol. As the seed reacted strongly acid towards litmus it is possible that a considerable quantity of alkaloids was not removed by the alcohol, but it was not desirable to add any alkali in this extraction for fear of affecting the proteids.

One thousand grams of the alcohol-exhausted and thoroughly air-dried meal were treated with successive quantities of ten per cent.

sodium chloride solution until saturation of the filtered extract with ammonium sulphate showed that no more proteid was removed. The united extracts were filtered clear, saturated with ammonium sulphate, the precipitated proteids were dissolved in brine, the solution was filtered and dialyzed for several days. The abundant precipitate thus produced was filtered out, washed by decantation with water and with alcohol and dried over sulphuric acid. The substance thus obtained weighed 279.0 grams.

The solution filtered from this globulin was saturated with ammonium sulphate, the precipitate produced was dissolved in water, the solution filtered and dialyzed until no more globulin separated. By this second dialysis 15.2 grams of globulin were secured. The solution filtered from this second portion of globulin was concentrated by dialysing in alcohol and the proteid completely thrown down by adding absolute alcohol. The precipitate which resulted was then dehydrated with absolute alcohol and dried over sulphuric acid. Only 4.20 grams of substance were thus obtained, indicating the presence of very little proteid soluble in water.

The residue of meal was washed with water, which took up no proteid, and exhausted by successive applications of 2-10 per cent. potash water. The alkaline extracts were filtered clear and treated with dilute acetic acid. No precipitate resulted until a decided excess of acid had been added. The proteid thus separated was washed with water and with alcohol, dried over sulphuric acid and weighed 60.53 grams.

The meal residue was next washed with water and with alcohol, dehydrated with absolute alcohol and thoroughly air dried. It weighed 192.0 grams, showing the lupin seed to contain over 80 per cent. of substance soluble in salt solution and very dilute alkali, an amount not approached by any other seed which we have examined.

The nitrogen was determined in the various products and the results are summarized in the following table:

AMOUNT OF PROTEID EXTRACTED FROM YELLOW LUPIN BY VARIOUS SOLVENTS.

Extracted residue contained 1.51 per cent. N. or		2.90	grams.
Proteid extracted by alkali,	60.53 grams, contained 16 43 per cent. N. or	9.95	"
Proteid extracted by salt solution	279.0 grams, contained 17.86 per cent. N. or	49.83	"
	15.2 grams, contained 18.09 per cent. N. or	2.75	"
Proteid extracted by water,	4.2 grams, contained 16.55 per cent. N. or	0.69	"
Total proteid, 358.93 grams.			
Total nitrogen accounted for		66.12	"
1,000 grnms of meal contained 8.49 per cent. N. or		84.90	"

We thus have 77.88 per cent. of the nitrogen accounted for.

We will next consider in order :

I. Proteids soluble in pure water.

II. Proteids insoluble in water, but soluble in sodium chloride solution.

III. Proteids insoluble in water and in salt solution, but soluble in dilute potash-water.

I. PROTEIDS SOLUBLE IN PURE WATER.

As just indicated, water-soluble proteids occur in yellow lupin seeds in very small amount. Much the largest quantity obtained in any of the numerous extractions made was that already described, which formed 0.42 per cent. of the alcohol-extracted meal or 0.37 per cent. of the original meal. On treating this substance with water, a very considerable part was found to be coagulated. Since proteoses are not supposed to be rendered insoluble by prolonged treatment with alcohol, this insoluble matter was probably coagulated albumin or globulin, or possibly a mixture of both. The aqueous solution filtered from this insoluble proteid yielded a very small flocculent coagulum at 59°. The solution filtered after heating to 65°, became turbid at 67°, and flocks in minute amount appeared at 69°, which steadily increased until at 85° a very considerable coagulum had formed.

In another extraction by means of water, prolonged dialysis caused the separation of a small quantity of globulin which, when dissolved in salt solution, yielded a flocculent coagulum at 59° and but traces above 65°.

The solution from which most of this globulin had been removed by dialysis, gave a slight coagulum at 59°, and after heating to 65° the filtrate became turbid at 66°, and at 84° again yielded a small flocculent coagulum.

It is probable, therefore, that the substance coagulating at 59° is a globulin soluble in extremely dilute salt solutions which it is impossible to separate completely by dialysis and that the proteid coagulating at the higher temperature is an albumin.

Owing to the exceedingly small quantity of these proteids nothing further was learned respecting them.

The solution from which the coagulated proteid had been removed by heating gave a strong rose-red reaction with the biuret test, but no precipitate in the cold with nitric acid even after adding salt.

The yellow lupin seed accordingly contains a very small amount of albumin and a small quantity of proteose.

Neumeister (Zeitschrift für Biologie n. f.—**12**, 461) states that he found peptone in lupin seeds in large amount.

In order to test the seeds of the yellow lupin for peptones, 1,000 grams of freshly ground meal were treated with three liters of distilled water, and after agitating therewith for an hour the extract was strained through fine bolting cloth and the residue pressed out in a powerful screw press. Two liters of extract rich in dissolved substances was obtained, which was immediately saturated with ammonium sulphate and filtered. Lest peptones might be formed during the operation of extraction, the process up to this point was carried forward as rapidly as possible so that not over three hours elapsed before the solution, saturated with ammonium sulphate, was filtered. In order to be sure that the solution had been thoroughly saturated, a quantity of crystals of this salt were suspended in it over night, but no more proteid separated. Neumeister has stated that saturating seed extracts while hot and when made alternately acid and alkaline in reaction, is unnecessary. We, however, heated the solution to boiling, added ammonium sulphate as long as it dissolved, concentrated somewhat and allowed to cool. Much ammonium sulphate separated, but no noticeable quantity of proteose. After filtering off the separated sulphate, the solution was heated to boiling and concentrated until sulphate began again to crystallize out. Ammonia was next added to distinct alkaline reaction, and after heating a short time the solution was again cooled, filtered from deposited

sulphate and the filtrate concentrated until more sulphate separated. Acetic acid was added to acid reaction, the heating continued for a time, and the whole again cooled. After filtering out the separated crystals the solution measured 350 c. c. The solution was then nearly neutralized with ammonia, leaving its reaction slightly acid, and after adding an equal volume of water a freshly prepared solution of tannic acid was gradually added so long as a precipitate was produced in a small portion of the filtered liquid. A bulky reddish precipitate formed which, after standing 24 hours, was removed from the filter and treated with a slight excess of hot concentrated solution of baryta. After standing a short time the warm solution was filtered, and as it was very strongly alkaline from free ammonia, one-half was neutralized with sulphuric acid, thereby removing the excess of baryta. Neutral lead acetate was then added and the solution filtered. The most carefully applied biuret test did not show the least trace of peptone in this solution. The remainder was then evaporated nearly to dryness and about two cubic centimeters of syrup obtained which, if it had all been peptone, would hardly be considered a large amount. No peptone reaction whatever could be obtained with this syrup.

The other half of the solution was treated exactly as Neumeister directed—that is, neutral lead acetate was added without neutralizing the ammonia, and, after filtering, the biuret reaction was applied, but with no indication of peptone.

Since writing the above, S. Frankfurt (Landw. Ver.-Stat. **47**, 454) has stated that no peptone is present in seeds of the lupin, and attributes Neumeister's results to his long treatment of the seeds with water. In a letter to Frankfurt, Neumeister stated that after swelling the seeds in water they were rubbed up and digested with water for 24 hours, and that the vessels containing the extracting seeds were exposed to the direct action of sunlight in summer. It is thus evident that the peptone found by Neumeister was formed during the extraction and was not an original constituent of the seed.

II. *Proteids soluble in saline solutions.*

As just mentioned, a very small quantity of a globulin soluble in extremely dilute salt solutions, yielding a flocculent coagulum when its solution in ten per cent. sodium chloride is heated to 59°, was found in extracts of the yellow lupin seed. As but little of

this proteid is present in this seed, no attempt was made to do more than note its presence. Owing to its ready solubility in very dilute salt solutions, this proteid dissolves when lupin meal is treated with water. Besides this little if any other globulin substance is extracted from lupin seeds by the dilute saline solution which results when the meal is treated with water. Large quantities of globulin are, however, obtained by extraction with stronger salt solutions.

One hundred grams of meal yielded directly with salt solution an extract which was filtered clear, saturated with ammonium sulphate, the precipitate produced filtered out, dissolved in brine and the solution filtered clear and dialyzed for eighteen hours. The globulin thus precipitated was filtered out, washed with water, alcohol and ether, dried over sulphuric acid and found to weigh 12 grams. The filtrate by further dialysis similarly yielded 4.7 grams of globulin. These preparations, **1** and **2**, were analyzed with the results given below. The residue, remaining after exhausting 100 grams of meal with water, on treating with salt solution gave an extract which, when filtered clear and dialyzed four days, yielded 20.36 grams of globulin, preparation **3**, having the composition given in the following table. A large quantity of the globulin was prepared by extracting one kilogram of finely ground lupin meal with six liters of brine, filtering the resulting solution, saturating with ammonium sulphate, filtering out the precipitate produced, dissolving this in dilute salt solution, again precipitating by saturating with ammonium sulphate, re-dissolving the precipitate, filtering the solution so obtained and dialyzing for forty hours. The very large precipitate which separated was washed thoroughly by decantation with water, dilute alcohol, absolute alcohol and ether and then dried over sulphuric acid. In this way 112 grams of preparation **4** were secured having the composition given in the subjoined table. The filtrate from **4**, after three days further dialysis, gave a second precipitate of globulin which was decidedly more viscid than **4**. This by the usual treatment yielded 30 grams of preparation **5** with the composition given below.

Another portion of meal weighing one kilogram was several times extracted with water and the residue treated with successive applications of 10 per cent. salt solution. The extract was filtered clear and dialyzed for forty hours. The globulin so precipitated was thoroughly washed with water by decantation, then with

dilute alcohol and finally with absolute alcohol until no more color was removed, and finally with ether and then dried over sulphuric acid ; 120 grams of preparation **6** were thus obtained, giving on analysis the figures stated below. The solution from which **6** had separated was saturated with ammonium sulphate, the precipitate dissolved in brine and the solution returned to the dialyzer. After some days the small precipitate which had separated was filtered out, washed and dried in the usual manner and gave 5.0 grams of preparation **7** having the composition given below.

In order to avoid as far as possible any contamination of the proteid with nitrogenous or other substances soluble in alcohol, a quantity of very fine ground lupin meal was exhausted in a Squibbs percolator with a large quantity of strong alcohol, the process being continued until only a trace of solid matter remained after evaporating a considerable quantity of the alcoholic extract.

Two kilograms of this meal were then extracted as thoroughly as possible with brine, the solution filtered clear and saturated with ammonium sulphate. The proteids thus precipitated were dissolved in brine, the solution filtered perfectly clear and the globulin thrown down by dialyzing three days was filtered off, washed and dried in the manner already described. There was thus obtained 506 grams of globulin, preparation **8**.

The solution filtered from **8** by longer dialysis yielded 45 grams of preparation **9**. These preparations had the composition given below.

LUPIN GLOBULIN.

	1.	2.	3.	4.	5.	6.	7.	8.	9.
Carbon	50.62	50.68	50.63	50.49	50.29	50.41	49.81	50.20	49.47
Hydrogen ...	6.94	6.95	7.00	6.77	6.89	6.85	6.79	6.75	6.77
Nitrogen	17.45	17.89	18.05	17.90	17.88	18.01	17.79	17.86	18.07
Sulphur	0.77	0.80	0.88	0.88	1.25	0.87	1.48	0.98	1.49
Oxygen	24.22	23.68	23.44	23.96	23.69	23.86	24.13	24 21	24.20
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Ash	0.51	0.27	0.74	0.26	0.30	0.99	0.83	0.38	0.23

These figures agree quite closely except those for **5**, **7** and **9** in which carbon is less and sulphur decidedly more than in the others. The fact that these three preparations separated on prolonged dialysis of the solutions which had yielded **4**, **6** and **8** indicates the presence of two globulins, of different composition.

It was therefore necessary to submit this substance to very thorough fractional precipitation in order to determine definitely its true composition. Accordingly one hundred grams of preparation **6** were dissolved in 800^{cc} of five per cent. salt solution, filtered from a very small quantity of insoluble matter and the perfectly clear solution was mixed with 800^{cc} of water and cooled to 0°. A very large proportion of the dissolved proteid separated as a solid, coherent mass on the bottom of the beaker from which the clear solution was completely decanted. This precipitate was marked A, the solution B. The precipitate A was dissolved in 100^{cc} of ten per cent. brine, yielding readily a perfectly clear solution. This was mixed with 100^{cc} of water at 20° but no precipitate resulted. Water was then added gradually until an abundant precipitate formed and the total volume equalled 500^{cc}. After settling, the clear solution was poured off from the precipitate and the latter washed thoroughly with water and alcohol and dried over sulphuric acid. In this way 46.0 grams of preparation **10** were obtained, having the following composition.

LUPIN GLOBULIN, **10**.

Carbon	50.49
Hydrogen	6.77
Nitrogen	17.89
Sulphur	0.66
Oxygen	24.19
	100.00
Ash	0.51

The solution decanted from **10** was mixed with 600^{cc} more water, which gave another precipitate that, after washing and drying, weighed 10.5 grams and had the composition given below.

LUPIN GLOBULIN, **11**.

Carbon	50.18
Hydrogen	6.94
Nitrogen	17.93
Sulphur	0.82
Oxygen	24.13
	100.00
Ash	0.77

The solution B decanted from the first precipitate A as described above was diluted with an equal volume of water, cooled

to 0° and allowed to deposit the resulting precipitate. After washing and drying, preparation **12**, weighing 8.0 grams, was obtained, which gave the following results on analysis.

LUPIN GLOBULIN, 12.

Carbon	50.08
Hydrogen	6.82
Nitrogen	18.26
Sulphur	1.30
Oxygen	23.54
	100.00
Ash	0.74

The solution from which **12** separated was saturated with ammonium sulphate, the proteid thereby precipitated was dissolved in water and the clear solution dialyzed. A small precipitate resulted which when washed and dried weighed 1.40 grams and had the following composition.

LUPIN GLOBULIN, 13.

Carbon	49.54
Hydrogen	6.91
Nitrogen	18.24
Sulphur, Oxygen	25.31
	100.00
Ash	0.49

These fractional precipitations show a regular decrease in their content of carbon and an increase in both nitrogen and sulphur, that of the latter being especially marked. It is to be noted that the total weight of the foregoing fractions formed only 65.9 per cent. of the proteid taken, suggesting that the globulin was undergoing a change while in solution; but as no especial care was exercised to obtain all the proteid from the solutions, this process was repeated, not only with a view to settling this point, but to obtain larger quantities of the extreme fractions for further examination.

One hundred grams of preparation **8** were dissolved in 800^{cc} of five per cent. brine and the solution, after filtering perfectly clear, was mixed with 800^{cc} of water and cooled to 10°. The abundant precipitate which resulted was allowed to settle, and the solution decanted. The precipitate was marked C, the solution D. Precipitate C was next dissolved in 100^{cc} of ten per cent. brine and

300^{cc} of water at 20° added to the resulting solution. After standing some time the clear solution was decanted from the large deposit of proteid and the latter washed and dried. Thus were obtained 50.0 grams of preparation **14**, which analysis showed to have the following composition.

LUPIN GLOBULIN, **14**.

Carbon	50.71
Hydrogen	7.00
Nitrogen	17.86
Sulphur	0.67
Oxygen	23.76
	100.00
Ash	0.39

The filtrate from **14** was mixed with 400^{cc} of the first washings of **14** and cooled to 7°–8°. On standing, a part of the proteid deposited and the clear solution was then decanted. The precipitate, preparation **15**, after washing and drying weighed 8.46 grams, and according to analysis contained:

LUPIN GLOBULIN, **15**.

Carbon	50.14
Hydrogen	6.94
Nitrogen	17.83
Sulphur	0.86
Oxygen	24.23
	100.00
Ash	0.81

The solution from which **15** had separated was dialyzed but only a very small quantity of globulin could be obtained, preparation **16**, which weighed 0.7 gram and without correction for ash contained 18.22 per cent. of nitrogen. Solution D decanted from precipitate C as already described was cooled to 3°, that is 7° lower than before. This caused a further quantity of globulin to separate, which gave preparation **17**, weighing 21.14 grams.

LUPIN GLOBULIN, **17**.

Carbon	50.13
Hydrogen	6.88
Nitrogen	17.72
Sulphur	0.80
Oxygen	24.41
	100.00
Ash	0.59

The solution from which **17** separated was dialyzed free from chlorides and 13.7 grams of preparation **18** obtained having the following composition:

LUPIN GLOBULIN, **18**.

Carbon	50.04
Hydrogen	6.79
Nitrogen	18.43
Sulphur	1.48
Oxygen	23.26
	100.00
Ash	0.25

The filtrate from **18** contained but a very little proteid precipitable with ammonium sulphate. The total weight of these fractions was 94.0 grams; the 6 grams unaccounted for may be fairly attributed to mechanical loss and therefore a change of proteid to non-proteid substances is improbable.

These fractions, like those of the preceding series, show a decrease in carbon and an increase in nitrogen and sulphur as we pass from the least to the most soluble.

Another series of separations was next made by fractional solution.

One hundred grams of preparation **8** were dissolved in 800^{cc} of five per cent. brine, diluted with 800^{cc} of water at 20° and the solution cooled to 5°. The clear solution was then decanted from the separated proteid and dialyzed till free from chlorine. The globulin thus separated after washing and drying weighed 24.03 grams and had the following composition:

LUPIN GLOBULIN, **19**.

Carbon	50.11
Hydrogen	6.84
Nitrogen	18.46
Sulphur	1.28
Oxygen	23.31
	100.00
Ash	0.17

The proteid deposited by cooling as just described was dissolved in 700^{cc} of five per cent. brine and cooled at 5°. The clear solution was decanted and dialyzed, yielding 18.60 grams of preparation **20**, which contained:

LUPIN GLOBULIN, 20.

Carbon	50.27
Hydrogen	6.78
Nitrogen	18.43
Sulphur	1.15
Oxygen	23.37
	100.00
Ash	0.10

The substance precipitating on cooling as just described was dissolved in 600^{cc} of five per cent. salt solution, mixed with an equal volume of water and cooled to 2°. The clear solution was dialyzed and 5.6 grams of preparation **21** were obtained, which gave the following results on analysis:

LUPIN GLOBULIN, 21.

Carbon	50.03
Hydrogen	6.86
Nitrogen	18.47
Sulphur	1.49
Oxygen	23.15
	100.00
Ash	0.22

The precipitate that separated on cooling the solution from which **21** was obtained, was dissolved in 500^{cc} of five per cent. brine, diluted with an equal volume of water and cooled to 7°. The solution was decanted from the precipitate and dialyzed. Thus was obtained 4.31 grams of preparation **22**, which contained:

LUPIN GLOBULIN, 22.

Carbon	50.44
Hydrogen	6.92
Nitrogen	18.23
Sulphur	1.14
Oxygen	23.27
	100.00
Ash	0.11

The substance deposited by cooling, as last described, was dissolved in 300^{cc} of five per cent. salt solution, filtered clear and dialyzed till free from chlorides. The deposited globulin, after washing and drying, weighed 33.88 grams and contained:

LUPIN GLOBULIN, 23.

Carbon	51.13
Hydrogen	6.86
Nitrogen	18.03
Sulphur	0.49
Oxygen	23.49
	100.00
Ash	0.52

Like the preceding, this series of fractional separations shows a decrease in carbon and an increase in nitrogen and sulphur with increased solubility. The total weight of the fractions obtained was 86.42 grams, the loss being no greater than was to be expected.

Thirty-five grams of preparation **10** and the same quantity of preparation **14**, representing the least soluble portions obtained in the two first series of fractions, were next dissolved in 600^{cc} of five per cent. brine, diluted with an equal volume of water and cooled to 6°. The solution was decanted from the precipitate which resulted, filtered clear and dialyzed. The globulin thus precipitated after washing and drying weighed 12.43 grams and contained:

LUPIN GLOBULIN, 24.

Carbon	50.10
Hydrogen	6.94
Nitrogen	18.12
Sulphur	0.94
Oxygen	23.90
	100.00
Ash	0.23

The precipitate produced by cooling the solution, as just described, was dissolved in 500^{cc} of salt solution, diluted with 500^{cc} of water and cooled to 6°. The deposited proteid after the usual treatment weighed 7.80 grams and had the following composition:

LUPIN GLOBULIN, 25.

Carbon	50.32
Hydrogen	6.90
Nitrogen	18.06
Sulphur	0.81
Oxygen	23.91
	100.00
Ash	0.27

The substance separated by cooling as just described was dissolved in 1000^{cc} of two and one-half per cent. sodium chloride solution and cooled to 7°. The clear fluid, decanted from the thus precipitated proteid, was dialyzed and yielded 5.51 grams of globulin, giving on analysis the following results:

LUPIN GLOBULIN, 26.

Carbon	50.80
Hydrogen	6.91
Nitrogen	18.01
Sulphur	0.64
Oxygen	23.64
	100.00
Ash	0.23

The proteid separated by cooling the solution from which **26** had been obtained was dissolved in 500^{cc} of five per cent. salt solution, diluted with an equal volume of water and cooled to 14°. The clear solution was decanted and dialyzed and gave 4.9 grams of preparation **27**, which analysis showed to have the composition here given:

LUPIN GLOBULIN, 27.

Carbon	50.90
Hydrogen	6.85
Nitrogen	17.88
Sulphur	0.55
Oxygen	23.82
	100.00
Ash	0.27

The substance deposited at 14° as noted above was dissolved in 500^{cc} of five per cent brine, diluted to 1000^{cc} and allowed to settle at the temperature of the room (about 22°). The fluid was then decanted, dialyzed and further treated in the usual manner. There was thus obtained 5.45 grams of preparation **28**, which contained:

LUPIN GLOBULIN, 28.

Carbon	50.93
Hydrogen	6.94
Nitrogen	17.83
Sulphur	0.48
Oxygen	23.82
	100.00
Ash	0.23

The substance separated by diluting the solution from which **28** resulted was washed with water and alcohol, dried and found to weigh 20.6 grams. Its composition was:

LUPIN GLOBULIN, **29**.

Carbon	50.80
Hydrogen	6.83
Nitrogen	17.88
Sulphur	0.46
Oxygen	24.03
	100.00
Ash	0.70

This like the other series of fractional separations shows an increase in carbon and decrease in sulphur and nitrogen content accompanying a decrease in solubility. If the final fractions, which have been most thoroughly purified, are arranged as in the table below, it will be seen that a nearly constant composition has been reached, so that the average of these analyses may be taken as closely representing the composition of the least soluble and most abundant globulin of the yellow lupin.

YELLOW LUPIN GLOBULIN, CONGLUTIN.

	23	**26**	**27**	**28**	**29**	Average.
Carbon	51.13	50.80	50.90	50.93	50.80	50.91
Hydrogen	6.86	6.91	6.85	6.94	6.83	6.88
Nitrogen	18.03	18.01	17.88	17.83	17.88	17.93
Sulphur	0.49	0.64	0.55	0.48	0.46	0.52
Oxygen	23.49	23.64	23.82	23.82	24.03	23.76
	100.00	100.00	100.00	100.00	100.00	100.00

This is the globulin discovered by Ritthausen, and described by him under the name conglutin.

A careful examination of preparation **29** showed this globulin to have the following reactions:

In very dilute acids and alkalies it is completely soluble, yielding perfectly clear solutions of a light yellow color.

Dissolved in very dilute acetic acid, the proteid is precipitated by neutralizing the solution with sodium carbonate. On adding sodium chloride brine to the solution containing the precipitate in suspension, the latter is completely dissolved.

In ten per cent. sodium chloride brine it dissolves readily, giving a very slightly turbid solution of a pale yellow color, which

turns litmus paper red, lackmoid paper blue, and has no effect on tropæoline when evaporated to dryness with it.

A solution containing ten per cent. of the globulin dissolved in ten per cent. sodium chloride brine behaved as follows:

Dilution with twice its volume of water produced a considerable precipitate.

Addition of one drop of acetic acid, sp. gr. 1.035, or one drop of hydrochloric acid (1 part concentrated acid and 3 parts of water) to 5^{cc} of this solution gave a heavy precipitate.

Addition of mercuric chloride* dissolved in ten per cent. brine gave no precipitate.

Tannin as well as picric acid gave a heavy precipitate.

Diluted with an equal volume of ten per cent. brine, the solution, containing five per cent. of globulin, reacted as follows:

No precipitate was produced by saturation with sodium chloride, magnesium sulphate or sodium sulphate at 20°, but at 34° saturation with the last-named salt precipitated all but a minute trace of the globulin.

When the solution in ten per cent. sodium chloride brine, containing five per cent. of proteid, was heated gradually in a water bath, no change appeared even after heating some time at 100°. After more prolonged heating a thick transparent skin formed on the surface. On cooling and standing several hours, the solution set to a solid jelly and became somewhat turbid.

Addition of nitric acid to the solution in brine gave a precipitate not soluble in an excess of this acid. On heating, the usual xanthoproteic reaction occurred, which was preceded by the development of a slight pink color quickly changing to yellow, doubtless due to a trace of coloring matter still adhering to the proteid. When the globulin in the dry state was treated with very dilute nitric acid a clear solution resulted which gave a heavy precipitate on adding an excess of acid, that behaved on heating as just described. The usual proteid reactions were obtained with Millon's, Adamkiewics' and the biuret tests.

In order to determine the composition of the more soluble fractions, the greater parts of **18**, **19** and **20** were united, giving forty grams of substance which was dissolved in 400^{cc} of five per

* Palladin (Zeitschrift f. Biol. **31**, 195) states that 10 per cent. sodium chloride solutions are not precipitated by mercuric chloride, but that diluted solutions give precipitates soluble in salt solution. The precipitate which he thus obtained was of course caused by the water added with the mercuric chloride. If he had dissolved the mercury salt in brine, no precipitate would have resulted.

cent. brine, the solution was filtered perfectly clear, the filter washed with 100^{cc} of the same salt solution, and the filtrate and washings were mixed with an equal volume of water. After cooling to 8°, and standing some time a part of the globulin separated. From this the solution was decanted. The proteid was deposited as a viscid transparent fluid, which became opaque on treating with distilled water and finally solid. It was dehydrated with absolute alcohol and dried over sulphuric acid giving 19.2 grams of preparation **30**, having the following composition:—

LUPIN GLOBULIN, **30**.

Carbon	49.64
Hydrogen	6.87
Nitrogen	18.21
Sulphur	1.20
Oxygen	24.08
	100.00
Ash	0.32

The solution decanted from preparation **30** was mixed with 500^{cc} of water and cooled to 7°. The resulting precipitate, when treated in the same way as **30** had been, gave 9.25 grams of preparation **31**, containing:—

LUPIN GLOBULIN, **31**.

Carbon	49.62
Hydrogen	6.72
Nitrogen	18.22
Sulphur	1.36
Oxygen	24.08
	100.00
Ash	0.43

The solution from which **31** had separated was dialyzed free from chlorides, and yielded 7.4 grams of preparation **32**:

LUPIN GLOBULIN, **32**.

Carbon	49.59
Hydrogen	6.75
Nitrogen	18.43
Sulphur	1.62
Oxygen	23.61
	100.00
Ash	0.17

These three fractions have very nearly the same composition, which is in close agreement with that of the other most soluble fractions already described, as may be seen from the following table:

LUPIN GLOBULIN.

<table>
<tr><th></th><th>12.</th><th>18.</th><th>9.</th><th>30.</th><th>31.</th><th>32.</th><th>Average.</th></tr>
<tr><td>Carbon</td><td>49.54</td><td>49.63</td><td>49.47</td><td>49.64</td><td>49.62</td><td>49.59</td><td>49.58</td></tr>
<tr><td>Hydrogen</td><td>6.91</td><td>6.78</td><td>6.77</td><td>6.87</td><td>6.72</td><td>6.73</td><td>6.80</td></tr>
<tr><td>Nitrogen</td><td>18.24</td><td>18.43</td><td>18.08</td><td>18.21</td><td>18.22</td><td>18.43</td><td>18.27</td></tr>
<tr><td>Sulphur</td><td rowspan="2">25.31</td><td>1.48</td><td>1.49</td><td>1.20</td><td>1.36</td><td>1.56</td><td>1.42</td></tr>
<tr><td>Oxygen</td><td>23.68</td><td>24.20</td><td>24.08</td><td>24.08</td><td>23.67</td><td>23.93</td></tr>
<tr><td></td><td>100.00</td><td>100.00</td><td>100.00</td><td>100.00</td><td>100.00</td><td>100.00</td><td>100.00</td></tr>
</table>

A series of tests of preparation **30**, conducted at the same time and under identical conditions with those described for preparation **29**, revealed the following differences. In ten per cent. sodium chloride brine, **30** dissolved to a perfectly clear solution more colored than that yielded by **29**.

Preparation **30**, dissolved in brine to a solution containing ten per cent. both of salt and proteid, was not even rendered turbid by dilution with two volumes of water, but with three volumes a slight precipitate was given. A similar solution of **29**, with two volumes of water, gave a considerable precipitate, and with three volumes a very heavy precipitate.

5^{cc} of the ten per cent. solution of **30** required eight drops of acetic acid, sp. gr. 1.035, to produce a slight precipitate, while one drop under the same conditions gave a heavy precipitate in a similar solution of **29**.

With one drop of hydrochloric acid (one part concentrated HCl and three parts H_2O) only a turbidity was produced in the case of **30**, while under like conditions **29** yielded a heavy precipitate.

Saturation with sodium sulphate of the solution containing five per cent. of **30** gave only a partial precipitation, **29** being wholly precipitated under like conditions.

When this five per cent. solution in ten per cent. brine was heated in a water bath a turbidity formed at 94°, increasing as the temperature was raised, becoming dense at 99° and after long heating a gelatinous flocculent precipitate separated which was unchanged on cooling and standing; when heated with nitric acid the pink color which preceded the yellow of the xanthoproteic reaction was more pronounced than that yielded by **29**.

In all other respects no difference could be detected between the reactions of **30** and **29.** The most noticeable property in which both differ from nearly all other vegetable globulins is that neither yields insoluble products (the so-called "albuminates") when separated from solution. The only evidence of such a tendency noticed in the very large number of preparations made, was in some cases shown by the presence of a slight turbidity when precipitates were re-dissolved.

Both give solutions which react strongly acid with litmus. Titrated with standard ammonia, two grams of each of these globulins required the addition of ten milligrams of ammonia to cause an alkaline reaction with litmus.

Although the analyses of the final fractions of the more soluble globulin agree closely and their properties and reactions are quite alike, it seems to us doubtful if they represent a definite chemical species. The close physical and chemical resemblance between the least soluble substance and the most soluble, suggests that they are closely related. The distinct difference in some properties observed between the extreme products of fractional precipitation make it probable that a combination of some sort has taken place between the conglutin and other constituents of the seed.

As the lupin seed is unusually rich in soluble constituents, it would not be surprising if the proteid on precipitation carried down with it more or less of these substances which could be with difficulty separated afterwards. From the globulin of the blue lupin by fractional precipitation readily soluble products were obtained which however were wholly different in composition and quite distinct in reaction from the more soluble fractions of the yellow lupin globulin. The soluble fractions are possibly conglutin combined either chemically or mechanically with other constituents of the seed, which in the two varieties of lupin are apparently present in different proportions.

C. *Proteid insoluble in water and saline solution but soluble in dilute alkalies.*

As previously described on page 344, after exhausting one kilo gram of yellow lupin meal with ten per cent. sodium chloride solution and washing the residue with water, by continued extraction with two-tenths per cent. potash water a solution was obtained which after filtering clear and adding acetic acid to dis-

tinct acid reaction yielded a precipitate which after washing with water and alcohol and drying over sulphuric acid weighed 60.53 grams. This was re-dissolved in two-tenths per cent. potash water, the solution again filtered clear and carbonic acid passed through it. The proteid partly separated, but could not be filtered, so a little ammonium chloride was added to convert the potassium carbonate into chloride, but even after passing carbonic acid through the solution for some time and allowing it to stand over night in an ice box, only a partial separation resulted. Acetic acid was then added in slight excess and the precipitate filtered off and washed thoroughly with water and with alcohol. Dried at 110° this preparation, **33**, gave the following results on analysis:

LUPIN PROTEID, 33.

Carbon	51.40
Hydrogen	6.79
Nitrogen	16.43
Sulphur	1.03
Oxygen	24.35
	100.00
Ash	1.57

BLUE LUPIN.

One kilogram of fine ground meal of the seeds of the blue lupin was extracted with a large quantity of distilled water applied in successive portions and the residual meal thrown on fine bolting cloth after each application. The extract thus obtained was allowed to stand over night. The partly clarified liquid was syphoned off, saturated with ammonium sulphate, the precipitate dissolved in brine and the solution filtered clear and dialyzed for 48 hours. A precipitate resulted which was filtered off, washed with water and with alcohol and dried over sulphuric acid, giving preparation **34**, weighing 8.46 grams. The filtrate was dialyzed for ten days longer in a stream of water, but no more proteid separated. The solution was then concentrated by dialysis in alcohol and absolute alcohol added until all the proteid contained in it was precipitated. The substance thus obtained weighed when dry only 1.42 grams and was not examined further than to find that it was nearly all insoluble in water, having been coagulated by the prolonged treatment with alcohol. This insolubility of the greater part of this substance shows that very little proteose is present.

Like the yellow lupin, this seed contains but little proteid matter soluble in water, and that is mostly globulin dissolved by aid of the salts extracted from the seed.

The meal residue which had been exhausted with water was treated with ten per cent. sodium chloride solution and the extract, after filtering perfectly clear, was dialyzed for 40 hours. The globulin, which separated in a coherent mass on the bottom of the dialyzer, was washed thoroughly by decantation with water and with alcohol and dried over sulphuric acid. This gave 115.0 grams of preparation **35**.

Another preparation of this globulin was made by treating one kilogram of the meal directly with ten per cent. brine, filtering the extract perfectly clear and dialyzing for 40 hours. The globulin thus precipitated, after washing and drying, formed preparation **36** and weighed 112 grams. These three preparations were dried at 110° and analyzed with the following results.

	Blue Lupin Globulin.			Conglutin.
	34	**35**	**36**	Yellow lupin.
Carbon	50.58	50.82	50.85	50.91
Hydrogen	6.58	6.87	6.78	6 88
Nitrogen	17.82	18.04	18.04	17.93
Sulphur	0.72	0.40	0.50	0.52
Oxygen	24.30	23.87	23.83	23.76
	100.00	100.00	100.00	100.00
Ash	0.64	1.22	1.11	

The agreement between **35** and **36** and the purified conglutin of the yellow lupin is very close indeed, but in order to be sure that this was not accidental these two preparations were subjected to the following treatment.

One hundred grams of **35** were dissolved in 500^{cc} of five per cent. sodium chloride brine and 500^{cc} of water added to the solution. A large rapidly settling precipitate resulted which formed a semi-fluid mass on the bottom of the beaker, from which the very nearly clear solution A was poured after a short time. The precipitate B was dissolved in 280^{cc} of 6.5 per cent. brine and the resulting solution, which measured 380^{cc}, was diluted with an equal volume of water and cooled to 5°. The solution was then decanted from the precipitate, which was washed and dried as usual and found to weigh 39.2 grams, preparation **37**. The solution decanted from **37** was dialyzed until free from salt, whereby

a precipitate resulted which when washed and dried weighed 4.2 grams and formed preparation **38**. The solution A, decanted from precipitate B as above described, was cooled to 5° and the solution C decanted from the precipitate D. This precipitate was again dissolved in 300^{cc} of five per cent. brine, 300^{cc} of water added and the whole cooled to 5°. The precipitate thus produced when dried weighed 19.5 grams, preparation **39**. The solution from which **39** had separated was dialyzed and yielded preparation **40**, weighing 5.4 grams.

The solution C decanted from precipitate D was dialyzed free from chlorides and thereby 13.0 grams of preparation **41** was separated. These preparations were dried at 110° and analyzed with the following results. In the table they are arranged according to their solubility in dilute salt solutions.

	37	39	38	40	41
Carbon	51.25	51.04	50.82	50.98	50.79
Hydrogen	6.96	6.75	6.66	6.83	6.79
Nitrogen	18.11	18.15	17.69	17.66	17.64
Sulphur	0.32	0.24	0.49	0.38	0.39
Oxygen	23.36	23.82	24.34	24.15	24.39
	100.00	100.00	100.00	100.00	100.00
Ash	0.95	0.71	0.61	0.52	0.75
Amount	39.2	19.5	4.2	5.4	13.0 grams.

From these figures it would seem that preparation **35** contained some impurities, which accumulated in the three most soluble fractions in which the nitrogen is a little lower and the sulphur slightly higher than in the less soluble fractions. Preparation **36** was next fractionally precipitated in the following manner.

One hundred grams were dissolved in 700^{cc} of five per cent. sodium chloride brine, filtered perfectly clear and the solution diluted with an equal volume of distilled water. The proteid separated as a viscid liquid from which the solution E was decanted. The precipitate, F, was dissolved in 100^{cc} of five per cent. brine and the resulting solution, which measured 175^{cc}, was cooled in a freezing mixture to —4°, and then allowed to stand until it had warmed to 20°. The precipitate thus produced formed a perfectly transparent syrupy liquid which measured 61^{cc}. The solution from which this had separated was decanted and the fluid precipitate was washed by stirring up with water,

whereby it was rendered opaque and pasty. On washing with fresh quantities of water the substance became denser and granular. It was finally washed with alcohol and dried over sulphuric acid, giving 25 grams of preparation **42.**

The washings of **42** were cooled to 0° and 0.4 gram preparation **43** obtained. The solution from which this separated contained very little proteid, which was not saved. The solution E, decanted from precipitate F, was cooled to 8°, and the solution G was decanted from the proteid H, thus separated.

This precipitate was treated with 77^{cc} of five per cent. sodium chloride brine giving a solution measuring 126^{cc}, which was cooled to —10° and then allowed to stand until warmed to 20°, when 49^{cc} of a clear viscid liquid separated. This was washed with water in the same manner as **42** had been and then with alcohol, dried over sulphuric acid, and 18.5 grams of preparation **44** obtained. From the washings of **44** by cooling to 0° 2.62 grams of preparation **45** were separated. The solution G, decanted from precipitate H, was cooled in a freezing mixture until partly frozen, when it was allowed to melt and deposit the separated proteid. The latter, J, after decanting the solution I, was dissolved in 50^{cc} of five per cent. sodium chloride brine and the 75^{cc} of solution which resulted was cooled to —2°, but only a turbidity resulted. The solution was therefore diluted with an equal volume of water, again cooled to —2°, and slowly warmed to 20°. The proteid separated as a viscid liquid measuring 24^{cc} and when washed with water and alcohol gave 10.0 grams of preparation **46**. From the washings of **46** by cooling to 0° there separated 0.56 gram of preparation **47**. The solution I, decanted from precipitate J, was diluted with an equal volume of water and cooled to 0°. The substance which separated was washed with water and alcohol and when dried weighed 9.15 grams and formed preparation **48.** The solution from which **48** had separated contained too little proteid to save.

Dried at 110° these preparations gave the following results on analysis, which are arranged in the table in the order of their solubility.

	42	44	43	45	46	47	48
Carbon	51.09	51.14		50.86	50.94		50.65
Hydrogen	6.83	6.89		6.89	6.89		6.84
Nitrogen	18.08	18.10	17.82 +	17.95	17.79	17.77	17.56
Sulphur	0.38	0.33		0.46	0.27		0.44
Oxygen	23.62	23.54		23.84	24.11		24.51
	100.00	100.00		100.00	100.00		100.00
Ash	0.59	0.47	?	0.69	0.51	0.54	8.86
Amount	25.00	18.50	0.40	2.62	10.00	0.56	9.15 grams.

If the analyses of preparations **37, 39, 42** and **44,** which constitute the greater part of the proteid substance of **35** and **36,** are compared, it will be seen that they are in very close agreement and it is fair to presume that they represent very nearly the true composition of this the principal proteid of the blue lupin. If these analyses are also compared with those of conglutin from the yellow lupin, it will be evident that the two varieties of lupin contain one and the same globulin, especially since a rigid comparison of the reactions of purified preparations from the two seeds failed to reveal the slightest difference. The following table will facilitate a comparison of the above mentioned figures.

CONGLUTIN.

	Blue Lupin.					Yellow Lupin.
	37	39	42	44	Average.	Average.
Carbon	51.25	51.04	51.09	51.14	51.13	50.91
Hydrogen	6.96	6.75	6.83	6.89	6.86	6.88
Nitrogen	18.11	18.15	18.08	18.10	18.11	17.93
Sulphur	0.32	0.24	0.38	0.33	0.32	0.52
Oxygen	23.36	23.82	23.62	23.54	23.58	23.76
	100.00	100.00	100.00	100.00	100.00	100.00

If now we compare the analyses of the more soluble fractions as shown in the following table, they will be seen to be quite similar to each other but decidedly different from the more soluble globulin of the yellow lupin.

	38	40	41	46	47	48	Average.	Soluble globulin yellow lupin.
Carbon	50.82	50.98	50.79	50.94		50.65	50.84	49.58
Hydrogen	6.66	6.83	6.79	6.89		6.84	6.80	6.80
Nitrogen	17.69	17.66	17.64	17.79	17.77	17.56	17.69	18.27
Sulphur	0.49	0.38	0.39	0.27		0.44	0.39	1.42
Oxygen	24.34	24.15	24.39	24.11		24.51	24.28	23.93
	100.00	100.00	100.00	100.00		100.00	100.00	100.00

A comparison of the reactions of **41** with those of **37** showed that much less difference existed between the extreme fractions from the blue lupin than between those from the yellow. A ten per cent. solution of **37** in ten per cent. brine gave a considerable precipitate when diluted with twice its volume of water, while three times its volume were required to produce a slight precipitate in similar solutions of **41**. Solutions of both were precipitated with equal quantities of acid, **41** not needing the large excess of acid to cause precipitation which the soluble product from the yellow lupin required.

A solution of five per cent. of **37**, in ten per cent. brine, even after prolonged heating at 99°–100°, appeared wholly unaffected until the solution was subsequently cooled, when it solidified. A similar solution of **41** began to yield a flocculent coagulum at 75°, which at 80° was voluminous. After heating in a boiling water bath for some time nearly all the proteid was coagulated. As to the relations of these two substances, what was said on page 361, in our opinion, applies equally in this case.

Conclusion.

Both yellow and blue lupin seeds contain very little proteid matter soluble in water. The total quantity of proteid soluble in pure water obtained from the yellow lupin amounted to only 0.37 per cent. Of this a part consists of proteose. Whether the remainder is albumin, or a globulin soluble in extremely dilute salt solutions, which therefore could not be completely separated by dialysis, was not determined. Peptone is not contained in the freshly ground seed but is formed in small quantity after prolonged contact with water.

The greater part of the proteid matter contained in these seeds is soluble in saline solutions, the yellow lupin yielding 26.2 per cent. This is the body known as conglutin, but as heretofore described and as usually obtained it is contaminated with other substances present in the seed. Preparations from the blue lupin are usually much purer than those from the yellow, for the latter contain a considerable quantity of some sulphur containing substance from which conglutin can be separated by fractional precipitation out of dilute salt solutions. This explains why Ritthausen's conglutin from the yellow lupin contained twice as much sulphur as that from the blue lupin.

When purified no difference in properties and reactions can be detected between preparations from the two seeds.

The composition of conglutin as obtained by us is shown by the following figures.

CONGLUTIN.

	Yellow Lupin.	Blue Lupin.
Carbon	50.91	51.13
Hydrogen	6.88	6.86
Nitrogen	17.93	18.11
Sulphur	0.52	0.32
Oxygen	23.76	23.58
	100.00	100.00

Conglutin is readily soluble in sodium chloride solutions containing upwards of five per cent. of the salt. By sufficient dilution it is precipitated, a syrupy liquid separating which is rendered opaque and solid by treatment with water. Dissolved in salt solution, it is apparently unaffected by prolonged heating in a boiling water bath, but solutions thus heated on standing and cooling form a solid opalescent jelly which becomes clear and fluid on again heating. Unlike other globulins conglutin does not yield insoluble (coagulated) products by washing with alcohol or drying.

After exhausting lupin meal with salt solution, a small quantity of proteid can be extracted by two-tenths per cent. potash water, from which it is precipitated by adding acetic acid in slight excess but not by making the solution neutral to litmus. Only one preparation of this substance was made, which gave the following results on analysis.

Carbon	51.40
Hydrogen	6.79
Nitrogen	16.43
Sulphur	1.03
Oxygen	24.35
	100.00

Owing to the insolubility of this substance in any but alkaline fluids and the difficulty of making preparations of known purity nothing further was learned respecting it.

EFFECT OF MINUTE QUANTITIES OF ACID ON THE SOLUBILITY OF GLOBULIN IN SALT SOLUTIONS.

By Thomas B. Osborne and Geo. F. Campbell.

In a paper on crystallized vegetable proteids by one of us (Osborne, Am. Chem. Jour., XIV, 671) it was shown that the principal globulin of the seed of the castor bean is partly insoluble in a saturated solution of sodium chloride, and partly soluble therein, and that these two parts are alike in composition and but slightly different in reactions. Having found a proteid of similar composition and properties in the sunflower seed, we have again turned our attention to the globulin of the castor bean, with the hope that we might discover the cause of this partial precipitation by saturating its solutions with salt.

A considerable quantity of this globulin was prepared by extracting castor pomace with three per cent. brine at 60° and allowing the filtered extract to cool to the temperature of the room. The proteid thus separated was washed with water and alcohol, and dried over sulphuric acid. It formed a slightly colored dense powder consisting of a mixture of spheroids and octahedral crystals.

Seventy-five grams of this preparation were treated with 750^{cc} of ten per cent salt solution and, after agitating for some time, filtered from a large insoluble residue. This latter was washed thoroughly with ten per cent. brine and the filtrate and washings were united. In this way the substance was separated into two parts, one soluble and one insoluble, in cold salt solution. This solution was then saturated with sodium chloride and the large precipitate produced was filtered off, dissolved in ten per cent. brine and this process twice repeated. The saturated sodium chloride solutions filtered from these precipitations were united and dialyzed free from salt, the proteid thus precipitated was washed with water and alcohol, and dried over sulphuric acid. Thus 12.39 grams of preparation **A** were obtained, representing the fraction of this globulin soluble in cold ten per cent. brine and *not* precipitated by saturation with sodium chloride. The proteid which had been several times precipitated from solution by saturation with salt, as just described, was dissolved in ten per cent. brine, and the solution filtered perfectly clear and dialyzed. By the usual treatment 18.52 grams of preparation **B** were

obtained, representing the part of this globulin soluble in cold ten per cent. brine, but insoluble in saturated brine.

The part of the globulin which failed to dissolve in cold ten per cent. sodium chloride solution was next treated with salt solution of this strength, heated to 60° and allowed to cool to 14°. The greater part of the proteid was dissolved by this treatment, and after decanting the solution the undissolved residue was treated three successive times in the same way. The solutions obtained by this process were filtered clear from a slight quantity of suspended matters and saturated with sodium chloride, which precipitated all but an insignificant quantity of the dissolved proteid.

This precipitate was dissolved in ten per cent. brine filtered clear and dialyzed. The precipitated globulin, after filtering off, washing and drying, weighed 12.37 grams, and formed preparation **C.**

The part of the original globulin which failed to remain in solution after the above treatment with hot salt solution was dissolved in brine at 60°, filtered clear and allowed to cool over night. Very nearly all the proteid precipitated on cooling, and was washed and dried, giving preparation **D**, weighing 1.66 grams.

These four preparations were analyzed with very great care with the following results:

	A.	B.	C.	D.
Carbon	50.99	51.10	51.12	51.25
Hydrogen	6.92	6.87	6.95	6.97
Nitrogen	18.95	18.67	18.83	18.74
Sulphur } Oxygen }	23.14	23.36	23.10	23.04
	100.00	100.00	100.00	100.00
Ash	0.19	0.14	0.14	0.41

The difference between these results barely exceed the usual errors of analysis, although several determinations of each element in the different fractions indicate that these differences are not due to analytical errors. It would not be safe, however, to take such slight variations into account, especially when we consider the great difficulty in making perfectly pure preparations of proteids as well as exact combustions. We must, therefore, conclude that no difference in composition is proved to exist between these four preparations which present such marked differences in solubility. A comparative examination of these substances was made with the following results:

In ten per cent. brine at 20° A dissolved completely, B with the exception of a small residue, C partly, much being insoluble, while D did not dissolve at all. B and C dissolved nearly completely when warmed to 45°.

Five grams of each of A, B and C were dissolved in 50^{cc} of ten per cent. sodium chloride solution by heating to 50°. On cooling to 20° B and C deposited a very slight amount of proteid, but on cooling to 12° A gave a clear solution, while B deposited a not inconsiderable quantity of substance and C decidedly more. To 5^{cc} of each of these solutions at 20° were added 5^{cc} of water. A remained clear, B gave a slight precipitate, and from C practically all the dissolved globulin was thrown down, since further dilution of the solution filtered from this precipitate gave only a turbidity. With 5^{cc} more water added to A a turbidity resulted, while the same amount added to B gave a heavy precipitate. The dilution of A and B was continued until the strength of the salt solution was 1.66 per cent., when B yielded no more by further dilution, and A still contained dissolved globulin.

Five per cent. solutions of each of these proteids, in ten per cent. brine, when heated became turbid, A and B at 88°, C at 87° and flocculent coagula formed in A and C at 90° and in B at 91°, thus showing no difference in relation to heat.

Saturation with sodium chloride of the ten per cent. solution of this globulin gave a small precipitate in A, but completely precipitated B and C.

This partial precipitation of A shows that the substance precipitated by saturating with salt is a derivative of the body originally soluble in saturated brine.

In order to find the effect of minute quantities of acid added to these several fractions, two grams of each were treated with 20^{cc} of 0.05 per cent. acetic acid, or five milligrams of acid for each gram of proteid, which caused no noticeable solution. Two grams of salt were added to each whereby A was largely, B partly, and C but slightly dissolved. Heated to 50°, A gave a clear solution, B a nearly clear solution, while C dissolved only partly and precipitated on cooling to 20°.

The acid added to these solutions could not be detected by very delicate litmus paper, the reaction being perfectly neutral.

A solution of A was prepared in exactly the same manner, omitting the acetic acid, and the two solutions compared.

Diluted with an equal volume of water, no precipitate formed

in either solution, but with two volumes an abundant precipitate fell in that containing the acid, while only a very slight precipitate formed in the other.

Saturated with sodium chloride, the solution with acid gave a large precipitate, that without acid only a small one.

It is thus clear that a quantity of acid too small to be detected with litmus or by analysis causes changes in the fraction soluble in saturated salt solution, whereby products result having the same general properties as those exhibited by the fractions B and C.

In order to obtain more evidence on this point, these experiments were repeated and extended, using crystallized edestin from hemp seed.

Five grams of edestin were suspended in 50^{cc} of 0.05 per cent. acetic acid, 5 grams of salt were added and the solution was warmed to 50° to dissolve the insoluble "albuminate" present.

Another solution was then prepared in exactly the same manner without using acetic acid. Both solutions reacted perfectly neutral to litmus paper.

Equal volumes at the same temperature, and in test tubes of the same size were immersed in the same bath of cold water. The solution containing acid precipitated first and in far greater amount than the other.

Five cubic centimeters of each were diluted with an equal volume of water at 20°. The solution with acid gave a much greater precipitate than the other. After allowing these to stand and cool to 10° the precipitates were filtered off and one drop of strong acetic acid was added to each filtrate. The solution which had been made with acid gave only a turbidity, while a considerable precipitate formed in the other, showing that dilution precipitates the solution to which acid had been added far more readily than the solution without the acid.

Equal volumes of these solutions were saturated with salt, the precipitates filtered off, and one drop of acetic acid was added to each filtrate.

That from the solution made with acid gave only a turbidity while the other gave a very heavy precipitate.

Here again we see that the addition of a quantity of acid, too small to detect after the solution has been made, brings about changes similar to those naturally occurring in the seeds and extracts of the castor bean and sunflower and to those following

the addition of acid to that part of the globulin of the castor bean which is soluble in saturated salt solutions.

Whether such changes occur only through the influence of acids is a question not settled, and regarding which some doubt is raised by the fact that preparations of crystallized edestin which were originally soluble in ten per cent. sodium chloride solution, with the exception of a small quantity of "albuminate" and yielded solutions which gave only traces of precipitates on saturating with sodium chloride, were found, after keeping dry and in cork-stopped bottles two and four years, to have become largely insoluble in cold salt solution and to yield solutions which were nearly completely precipitated by saturating with salt. The insoluble portion dissolved nearly completely in ten per cent. brine at 60° to a solution precipitated somewhat by cooling to 20° and abundantly at lower temperatures, copiously precipitated by dilution with an equal volume of water, and almost completely precipitated by saturating with sodium chloride. It is not at all impossible that this change, too, may have been caused by acid, for these preparations stood during several years in the laboratory, the air of which at times contained some acid vapors. We thus see the same changes taking place in the dry proteid on long keeping as those definitely caused by minute quantities of acid.

That this change to a condition in which the globulin is precipitated by salt is an intermediate step towards the formation of the insoluble form, the so-called "albuminate" of Weyl, is evident from what has been already stated, especially the fact that by treatment with warm salt solution this insoluble matter can be changed into the form soluble in cold salt solution and precipitable by saturation with salt.

In this connection it is interesting to note that the only animal globulin obtained from an acid tissue is myosin, and that this myosin not only is readily precipitated by saturating with salt, but quickly and spontaneously changes to the insoluble form known as syntonin. In the dead muscle the amount of acid greatly exceeds that used in our experiments, for its presence is plainly shown by the strong acid reaction of the muscle serum. In alkaline muscle plasma myosin is not found, but myosinogen, paramyosinogen and myoglobulin. The last three are described as precipitated by saturation with sodium chloride, but it may be that when tested in this respect the formation of acid had already begun and had reached a point where it caused precipitation with salt but could not be detected by the usual tests.

THE PROTEIDS OF THE SUNFLOWER SEED.

By Thomas B. Osborne and George F. Campbell.

The only published observations on the proteid of the sunflower seed which we have found were made by Ritthausen (Pflüger's Archiv XXI. 89, 1880) and by Vines (Jour of Physiology III. 93). By extracting with very dilute alkali Ritthausen obtained from finely ground oil-free meal 44.71 per cent. of proteid, having the composition given under **1**. By treating with sodium chloride brine, diluting the extract with five volumes of water and passing carbonic acid through the solution, he got 25.8 per cent. with the composition given under **2**, and by exhausting a preparation obtained in the same manner as **1** with brine, and proceeding as with **2**, he got a preparation whose analysis is given under **3**.

Sunflower Proteid. Ritthausen.

	1	2	3
Carbon	51.88	51.51	51.18
Hydrogen	6.66	6.76	6.82
Nitrogen	17.99	18.21	18.06
Sulphur	0.71	0 61	23.94
Oxygen	22.76	22.91	
	100.00	100.00	100.00

Vines states that if a section of sunflower seed be treated with ether to remove oil it will be found that the aleurone grains, though readily soluble in 10 per cent. sodium chloride solution, will not dissolve in saturated solution; if, however, they be treated with alcohol instead of ether, the globulin of which these grains consist behaves like vitellin, that is, it dissolves in a saturated solution of sodium chloride.

Vines further states that "it is of interest to note the fact that most of the substances which I found in the grains recur in the crystalloids, more especially vitellin and its derivatives; thus the peculiar globulin which forms the crystalloids of Ricinus appears to be in the grains of Helianthus."

Ritthausen's results indicate that by far the greater part of the proteid matter of the sunflower-seed has a uniform composition, and that a large part of this proteid is insoluble in salt solution, but soluble in dilute alkali. The composition which he found for this proteid resembles that of the globulin edestin, which we have found in many seeds, the only difference being a slightly lower

content of nitrogen. On this account it seemed to us desirable to examine this proteid and determine its relation to edestin. This was the more important, because Vines' statement of its behavior when treated with ether and with alcohol showed it to possess the same peculiar relations to salt solutions observed by one of us (Osborne, Report Conn. Expt. Station, 1892, p. 138, and Am. Chem. Jour. **14,** 671) in studying the globulin of the castor bean, *Ricinus communis.* As the deportment of globulins to saturated sodium chloride solutions has been made the basis of a division of these bodies into two main classes, it is important for us to know whether this is founded on fundamental differences in the proteids, or is simply due to the unlike conditions under which the proteids are found.

Sunflower seeds were crushed and a large part of the woody shells removed. The meal was then ground under benzine and, after freeing from oil, air dried. This meal when treated with ten per cent. sodium chloride brine yielded an extract of a strong blackish green color, from which a considerable quantity of proteid could be separated by dilution, by dialysis or by saturation with sodium chloride.

When heated, this extract becomes turbid at 48° and flocks separated at 62°. The solution heated to 75° and filtered from this slight coagulum yields a large precipitate when saturated with salt, thus showing that most of the substance thus precipitated is not, as *myosin* is said to be, coagulated below 75°.

The unheated extract saturated with sodium chloride gives a precipitate which when dissolved in ten per cent. brine coagulates at the same temperature as the original extract, but the amount of this coagulum is but a small fraction of the substance precipitated by saturation with salt.

The following preparations were made, but as subsequently pointed out were found to be more or less impure, so that these results have value only as affording evidence of the uniform composition of the globulin extracted by salt solution from the sunflower seed.

	1	2	3	4	5	6	7	8	9
C...	51.57	51.77	51.65	51.69	51.85	....	....	....	....
H...	6.81	6.83	6.72	6.80	6.84	....	....	....	....
N...	18.16	18.20	18.17	18.24	18.00	18.20	18.23	18.09	18.07
S... } O... }	23.46	23.20	23.46	0.78 22.49	23.31	....	....	....	....
	100.00	100.00	100.00	100.00	100.00				

Of these, **1** is the total globulin extracted by brine from one portion of oil-free meal; **2, 3, 4** and **5** are fractional precipitates from another similar extraction; **6,** substance precipitated by saturating the salt extract with sodium chloride; **7** and **8,** substance soluble in saturated sodium chloride solution, and **9,** that precipitated by cooling an extract made with a one and a half per cent. salt solution heated to 60°.

These results show that the most abundant proteid of the sunflower seed consists of a single globulin, and that the proteid precipitated by saturating with sodium chloride contains the same amount of nitrogen as the proteid soluble in a saturated solution of this salt. As Vines stated that the substance of the aleurone grains was soluble in a saturated salt solution after treatment with alcohol, while after treatment with ether it was insoluble therein, although soluble in ten per cent. salt solution, we thought that possibly by treating our meal with alcohol we might remove some substance, perhaps an acid soluble in alcohol but insoluble in ether, which might be the cause of this peculiar behavior of the proteid. We accordingly extracted a quantity of sunflower meal with alcohol of 0.820 sp. gr. and in order to determine whether acid had been removed we attempted to titrate a portion of the extract with a one per cent. solution of potash. On adding the alkali a colored precipitate resulted which rendered the indicator (*phenolphthalein*) useless. The attempt was then repeated, omitting the indicator. When the potash solution was added a bright chrome yellow color resulted, which gradually increased with the formation of a precipitate as the quantity of potash was increased. With a larger excess of potash the precipitate redissolved. This reaction we found to be due to helianthotannic acid (Ludwig and Kromayer, N. Br. **99,** 1 and 285). The results of our investigation of this acid will be given in another paper.

Having now found a very delicate test for this acid, we applied it to our preparations of globulin and obtained a strong reaction in every case. It was therefore necessary to remove this acid from the meal before attempting to obtain the proteid and accordingly the extraction of the meal with alcohol was continued. It was, however, practically impossible to remove the acid so completely as to obtain no yellow reaction when the extract was treated with potash.

The meal which had been nearly freed from this acid was

washed with ether and air dried. 100 grams were extracted with ten per cent. sodium chloride brine and the filtered extract saturated with salt. An abundant precipitate separated, just as with meal which had not been treated with alcohol. This was filtered off, dissolved in ten per cent. brine and again precipitated by saturation with salt. This precipitate was again dissolved in salt solution, filtered perfectly clear and dialyzed. The globulin which was thus precipitated was filtered out, washed with water and alcohol and dried over sulphuric acid. This preparation, **10,** weighed 7.4 grams and had the following composition:

SUNFLOWER GLOBULIN, *Preparation* **10.**

Carbon	51.27
Hydrogen	6.55
Nitrogen	18.21
Sulphur	0.78
Oxygen	23.25
	100 00
Ash	0.31

The saturated sodium chloride solutions filtered from the two precipitations of **10,** were united and dialyzed until free from chloride, the resulting precipitate was filtered out and treated as **10** had been. Preparation **12** was thus obtained, which on analysis gave the following results:

SUNFLOWER GLOBULIN, *Preparation* **12.**

Carbon	51.58
Hydrogen	6.55
Nitrogen	18.29
Sulphur	0.97
Oxygen	22.61
	100.00
Ash	0.29

As both the preceding preparations were found to contain detectable quantities of helianthotannic acid another attempt was made to prepare some meal which should be practically free from this acid.

One hundred grams of meal were therefore extracted in a Squibbs percolator with alcohol of 0.820 sp. gr., the whole being kept at 65° C. until 1500^{cc} of extract were obtained.

The temperature was then raised to 75° and the extraction con-

tinued, about seven liters of alcohol being passed through the meal. The last two liters were evaporated and left a residue weighing only 0.28 grams.

The meal residue was air dried and extracted with ten per cent. sodium chloride solution. The extract was then filtered clear and saturated with ammonium sulphate, the precipitated proteid filtered out, dissolved in brine, the solution filtered perfectly clear and dialyzed.

The proteid was thus precipitated in large spheroids and was filtered out, washed with water and alcohol, dried over sulphuric acid and found to weigh 15.5 grams, preparation **13.** This substance was freer from coloring matter than any before made, and had the following composition:

SUNFLOWER GLOBULIN, *Preparation* 13.

Carbon	51.54
Hydrogen	6.99
Nitrogen	18.58
Sulphur	1.00
Oxygen	21.71
	100.00
Ash	0.47

This preparation, which was very nearly white in color, dissolved after drying almost wholly in ten per cent. sodium chloride brine at 20°, giving a solution slightly tinged with greenish brown, which on dilution yielded an abundant precipitate that on warming, while suspended in the diluted solution, redissolved completely and again separated on cooling in spheroids, and on settling united to a coherent layer.

Solutions in ten per cent. sodium chloride brine behaved as follows:

When saturated with magnesium sulphate at 20° or sodium sulphate at 34°, the proteid was completely thrown out of the solution. When saturated with sodium chloride it was partly precipitated.

With mercuric chloride, picric acid or tannic acid a heavy precipitate was produced.

With minute quantities of nitric, sulphuric, hydrochloric or acetic acid the globulin was precipitated.

In pure water this preparation formed a plastic mass, but none dissolved.

In water containing a minute quantity of acid it dissolved readily and completely.

With the xanthoproteic, Millon's, biuret and Adamkiewics' tests the usual proteid reactions were obtained.

When dissolved in ten per cent. sodium chloride solution and tested for heat coagulation point in the usual manner a turbidity formed at 90°, and a flocculent coagulum began to separate at 93°, increasing as the temperature was raised toward 100°. After heating some time in a boiling water bath a considerable coagulum formed, yet a large proportion of the substance still remained in solution, as shown by the voluminous precipitate produced on adding acetic acid to the solution filtered from the coagulum.

In composition and reaction this preparation agrees with the globulin edestin except that a part is precipitated by saturating its solutions in brine with sodium chloride. In composition the part precipitated by saturating with salt and that remaining in solution are alike. We have in another paper (this Report, p. 369) pointed out that the globulin of the castor bean shows a similar behavior, and that the part precipitated by saturating with salt is a derivative of the part soluble in saturated salt solutions. We have further shown that the addition to a solution of edestin of a quantity of acetic acid too small to detect after mixing with the proteid, causes a precipitation of the edestin on saturating its solution with brine, and that under these conditions, the proteid otherwise behaves like the globulin from the castor bean and sunflower seed.

As helianthotannic acid contains about 53.0 per cent. of carbon the presence of two per cent. of this acid in our preparation would but slightly raise the figures obtained for carbon and reduce those for nitrogen by about 0.35 per cent. The composition of the purer preparations which we have obtained differ from edestin to about this extent.

It is therefore our opinion that the sunflower seed contains as its principal proteid the globulin edestin, but that as obtained by extraction from the seed, this is mixed with helianthotannic acid, from which we have not succeeded in separating it completely.

Having thus found that a large part of this globulin is insoluble in saturated salt solutions under all the conditions of our tests, we were led to repeat Vines' experiments, but have been unable to confirm his observations, the aleurone grains appearing to be wholly unaffected by saturated salt solution after treatment of the seed with alcohol.

THE PROTEIDS OF THE COW PEA, (*Vigna Catjang.*)

BY THOMAS B. OSBORNE AND GEORGE F. CAMPBELL.

The proteids of this plant have never been, to our knowledge, the subject of study. Because of its great and increasing agricultural importance, and as a plant differing botanically from those included in our investigation of "legumin," the proteids of its seeds have much interest. The material examined was prepared by coarsely grinding the peas, separating the black seed-coats by a current of air, and then grinding the coarse meal to a fine flour. Two kilograms of this flour were treated with a quantity of ten per cent. sodium chloride solution, the extract was strained through fine bolting cloth and allowed for three hours to deposit the greater part of the suspended starch. The extract was then run through a DeLaval centrifugal separator, whereby most of the remaining suspended starch and fiber was removed, and lastly was filtered perfectly clear by passing through a thick layer of filter paper pulp. The extract was saturated with ammonium sulphate, the precipitated proteids were collected on a filter, and dissolved in brine. The solution was filtered perfectly clear and dialyzed for four days.

The proteid, thus separated, in the form of spheroids, was designated **A**, and the solution filtered therefrom was marked **B**. **A** was collected on several paper filters. One portion was washed very thoroughly with water and with alcohol and, dried over sulphuric acid, gave preparation **1**, which weighed 29.7 grams. The rest of **A** was dissolved in one liter of five per cent. sodium chloride brine, and the solution filtered perfectly clear. On adding one liter of distilled water a large precipitate, **D**, separated, which was allowed to settle over night. The fluid, **C**, was then decanted from the proteid, **D**, which had formed a coherent deposit. **D** was dissolved in 150^{cc} of ten per cent. sodium chloride brine with which it readily yielded a clear solution, and water was added to make the volume one liter. A rapidly settling precipitate appeared that soon united to a coherent layer, from which the nearly clear liquid was decanted. After thoroughly washing this precipitate with water and with alcohol and drying it over sulphuric acid there resulted 50.9 grams of preparation **2**. The solution decanted from **2** was treated with 200^{cc} of water, causing a precipitate which, washed and dried as before, gave 12.83 grams of preparation **3**. Similarly the solution

decanted from **3**, when mixed with 200^{cc} more water, gave 6.2 grams of preparation **4.**

The solution decanted from **4** was dialyzed until chlorides were removed, which treatment precipitated all but a trace of the dissolved proteids. In this way 4.4 grams of preparation **5** were obtained.

The solution **C**, decanted from the precipitate **D**, as described on page 380, was diluted with 500^{cc} of water. The proteid thus thrown down, after washing and drying, formed preparation **6**, which weighed 16.9 grams. The filtrate from **6** was dialyzed for two days, and a deposit obtained weighing when dry 10.5 grams, **7.** The filtrate from **7** was nearly free from proteid matter.

These preparations were analyzed, after drying at 110°, with the following results :

	1	2	3	4	5	6	7
Carbon	52.45	52.69	52.63	52.56	52.52	52.59	52.27
Hydrogen	6.92	6.77	6.90	6.98	7.04	7.08	6.97
Nitrogen	17.16	17.18	17.50	17.18	17.27	17.24	16.99
Sulphur	0.40	0.57	0.52	0.62	0.53	0.56	0.50
Oxygen	23.07	22.77	22.45	22.66	22.64	22.53	23.57
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Ash	0.32	0.64	0.47	0.50	0.42	0.45	0.16

It will be noticed that the first six preparations are nearly identical in composition. Of these, **1** represents the globulin precipitated by dialyzing the solution of the ammonium sulphatep recipitate (which contained all the proteid matter extracted from the seed). **2, 3, 4** and **5** are four fractions of that portion of the substance (of which **1** was a part) that is most readily precipitated by dilution. **6**, which also agrees with the foregoing, is that part of the remainder thrown down by further diluting the solution filtered from the precipitate, yielding **2, 3, 4** and **5**, while **7, 8, 9** and **10** are portions more soluble in very dilute salt solution. In composition, **7** differs from **1–6.** Although the figures obtained for **1** closely agree with those for **2, 3, 4** and **5**, the former has been shown to contain about ten per cent. of the globulin, **7**, whose presence in this proportion affects but slightly the percentage composition of **1.** It will be noticed that **8** and **9** contain more carbon and sulphur than the other preparations. If these analyses are compared with those of similarly obtained preparations from the pea and vetch, it will be seen that they are

all in close agreement. The relation of these proteids will be discussed later.

Remarking that **7** agrees in composition with the globulin phaseolin and that preparations **1–6** have a composition corresponding to a mixture of equal parts of phaseolin and legumin, we thought it important to determine whether or not this substance contained these two proteids. Phaseolin being much more readily soluble in dilute saline solutions than legumin, these globulins may be separated by fractional precipitation. Accordingly twenty grams of **2** were treated with 500^{cc} of five per cent. sodium chloride brine, and the solution was filtered off from the undissolved "albuminate." The filtrate, which measured 378^{cc}, was diluted with four times its volume of water, to produce a one per cent. brine, in which phaseolin dissolves freely and legumin somewhat sparingly. An abundant precipitate fell, which was filtered out, washed and dried as usual, and formed preparation **11.** The filtrate from **11** was saturated with ammonium sulphate, and the very small precipitate produced was dissolved in water and dialyzed. Only 0.3 grams of globulin was thus obtained, showing that very little of the proteid was soluble in one per cent. salt solution.

The residue which remained undissolved after treating **2** with five per cent. sodium chloride brine, was washed by decantation with salt solution, heated to about 50° and the filtered washings dialyzed. Preparation **12** was thus precipitated.

The portion of **2** that remained undissolved by this treatment was thoroughly washed with water and alcohol and dried over sulphuric acid, making preparation **13.** These were dried at 110° and analyzed with results that follow:

	11	12	13
Carbon	52.74	52.70	52.87
Hydrogen	6.94	6.97	6.95
Nitrogen	17.22	17.21	17.29
Sulphur	0.40	0.42	0.49
Oxygen	22.70	22.70	22.40
	100.00	100.00	100.00
Ash	0.66	0.73	0.64

It is evident that no fractional separation was accomplished by this treatment, and that the most abundant globulin of the cow

pea must be regarded as a distinct proteid, differing from any heretofore described. For this proteid we propose the name *vignin.*

Its composition as represented by an average of the foregoing figures is here stated :

VIGNIN.

Carbon	52.64
Hydrogen	6.95
Nitrogen	17.25
Sulphur	0.50
Oxygen	22.66
	100.00

The reactions of vignin are as follows: In cold or warm water, when free from soluble salts, it dissolves to a considerable extent, the solutions resulting being precipitated by adding a very little salt. The precipitate so separated dissolves completely on adding more salt.

It is readily soluble in sodium chloride solutions, containing upwards of five per cent. of salt, from which solutions it is promptly precipitated by dilution. In two and one-half per cent. salt solutions relatively little, and in 1.0 per cent. very little dissolves. It is readily and completely soluble in dilute acids and alkalies in absence of salts. Solutions in very dilute nitric or hydrochloric acid are precipitated by salt or by an excess of these acids. In dilute sulphuric acid it is much less readily soluble than in the acids just named, and is not precipitated by an excess of sulphuric acid and but slightly on adding salt. Solutions in very dilute acetic acid are not precipitated by an excess of this acid but give heavy precipitates on adding sodium chloride. Dissolved in one-half per cent. sodium carbonate solution, the proteid is precipitated by neutralization, the separated proteid at once dissolving on adding salt. Dissolved in ten per cent. sodium chloride brine, this globulin behaves as follows:

By hydrochloric acid it is not precipitated until a relatively considerable quantity of the acid is added. By this acid the globulin is less readily thrown down than legumin but more readily than phaseolin.

The same is true of acetic acid, of which a somewhat large quantity is required to cause a precipitate. Phaseolin is not precipitated at all under these conditions.

By diluting the salt solutions of vignin it is apparently more readily precipitated than legumin, and far more readily than phaseolin.

Saturation of solutions of vignin with sodium chloride or magnesium sulphate gives no precipitate, but saturation with sodium sulphate at 34° causes nearly complete precipitation of the proteid.

Mercuric chloride gives no precipitate; tannic acid and picric acid make heavy precipitates in its solutions.

With Adamkiewics', Millon's, the biuret and xanthoproteic tests the usual proteid reactions are obtained.

Strong solutions of this globulin dissolved in ten per cent. sodium chloride become turbid when heated to 98°, and after continued heating set to a jelly.

Besides vignin the cow pea contains a small quantity of proteid matter represented by preparation **7**, which in composition, as well as reactions, agrees very closely with phaseolin. Phaseolin differs from all other plant globulins, which we have thus far observed, in not being precipitated from its solution in ten per cent. sodium chloride brine by a large quantity of acetic acid. In this respect **7** behaves like phaseolin.

The composition of phaseolin as obtained from different seeds is shown by the following statement:

PHASEOLIN.

	Cow pea.	Kidney bean.	Adzuki bean.
Carbon	52.27	52.58	52.56
Hydrogen	6.97	6.84	6.97
Nitrogen	16.69	16.47	16.45
Sulphur	0.50	0.56	0.57
Oxygen	23.57	23.55	23.45
	100.00	100.00	100.00

The solution **B**, filtered from **A**, as described on page 380, was saturated with ammonium sulphate and the small precipitate produced was dissolved in a little dilute salt solution, filtered perfectly clear and dialyzed for two weeks. A precipitate resulted which was filtered out, washed with water and alcohol and dried over sulphuric acid. This preparation, **8**, weighed 3.2 grams. The filtrate from **8** was dialyzed ten days longer, but as nothing separated, the solution was dialyzed against alcohol. A small precipitate, **9**, appeared, which weighed 3.75 grams.

These preparations after drying at 110° were analyzed with the following results :

	8	9
Carbon	53.13	53.36
Hydrogen	7.09	7.05
Nitrogen	16.51	16.21
Sulphur	1.09	1.13
Oxygen	22.18	22.25
	100.00	100.00
Ash	0.65	0.81

It will be noticed that these two preparations agree quite closely in composition. Although 8 was precipitated by dialysis in water and is unquestionably a globulin, while 9 could not be precipitated by even prolonged dialysis, nevertheless it is our opinion that these are one and the same proteid. In a subsequent paper we hope to point out the relations of this globulin to the proteids obtained similarly from other leguminous seeds.

Conclusion.

1. The chief proteid of the cow pea is a globulin, much resembling the legumin of the pea and vetch, but essentially different in composition and properties, for which we propose the name *vignin*. Its composition, as found by the average of closely agreeing analyses of nine fractional precipitates, is as follows :

VIGNIN.

Carbon	52.64
Hydrogen	6.95
Nitrogen	17.25
Sulphur	0.50
Oxygen	22.66
	100.00

2. Besides vignin, the cow pea contains a globulin which has the composition and, so far as could be determined, the properties of phaseolin, which we have found in the kidney bean (*Phaseolus vulgaris*), and the adzuki bean (*Phaseolus radiatus*).

3. The cow pea contains a third globulin, extremely soluble in very dilute salt solutions, which could be precipitated but partially by dialysis in water and completely only in the coagulated

form by dialysis in alcohol. This substance closely resembles in properties and composition bodies obtained from several other leguminous seeds. Its composition, as found by analysis of two precipitates, one obtained by dialysis in water and the other by further dialysis in alcohol, is as follows:

Carbon	53.25
Hydrogen	7.07
Nitrogen	16 36
Sulphur	1.11
Oxygen	22.21
	100.00

PROTEID OF THE WHITE PODDED ADZUKI BEAN (*Phaseolus radiatus*).

BY THOMAS B. OSBORNE AND GEORGE F. CAMPBELL.

This is a small red bean cultivated in Japan. The seeds used in this investigation were grown in Kansas and sent to us by Prof. C. C. Georgeson.

As our object was to discover the nature of the globulin forming the chief proteid constituent of various leguminous seeds, no attempt was made to determine the total amount of proteid contained in this seed, nor to study the other proteid substances occurring in small quantity.

It was impossible, by any means at our command, to remove the closely adhering red seed-coat, but as it was found that this yielded but little coloring matter to salt solutions the entire seed was ground until all passed a sieve of fine bolting cloth.

Two kilograms of this meal were treated with eight liters of ten per cent. sodium chloride solution, and after stirring some time the mixture was strained on fine bolting cloth.

After standing long enough to deposit most of the suspended starch the extract was filtered quite clear and saturated with ammonium sulphate. The precipitate so produced was filtered out, suspended in water and, in order to remove the adherent ammonium sulphate, which prevented solution of the proteid in a sufficiently small volume of water, the mixture was dialyzed over night. The proteid was thus completely dissolved. The solution was filtered perfectly clear and again dialyzed four days. A large precipitate of globulin resulted, which was filtered out and a portion collected on a separate paper and washed thoroughly with water and alcohol and dried over sulphuric acid. This was found to weigh 13.21 grams and formed preparation **1**.

The remainder of the globulin was suspended in 850^{cc} of water and 150^{cc} of ten per cent. salt solution added, which yielded a nearly clear solution, showing the globulin to be readily soluble in one and a half per cent. brine. The solution was filtered clear and the filter washed with 100^{cc} of 1.5 per cent. salt solution. The filtered liquid, measuring 1100^{cc}, was treated with 500^{cc} of water, thereby throwing down a large, rapidly settling precipitate which, after decanting the fluid, was dissolved in ten per cent. salt solution, filtered perfectly clear and dialyzed for three days. The

globulin was thus nearly completely precipitated, for further dialysis of the filtered solution caused separation of very little more. Under the microscope the globulin appeared as well developed spheroids. After filtering, this precipitate was washed with water and with alcohol and dried over sulphuric acid. This formed preparation **2**, weighing 41.5 grams.

The solution decanted from the first precipitation of **2**, caused by the addition of 500^{cc} of water as described above, was further diluted with 500^{cc} of water, which caused an abundant separation of proteid. After settling over night the clear solution was decanted from the precipitate and the latter washed thoroughly with water and with alcohol and dried over sulphuric acid, giving preparation **3**, weighing 31.34 grams.

The solution decanted from **3** was cooled over night in an ice chest to 9°, which caused a further separation of proteid in large spheroids. This was filtered off, washed with water and alcohol, dried over sulphuric acid and found to weigh 6.18 grams, preparation **4**.

The filtrate from **4** was dialyzed for 24 hours and filtered from an abundant precipitate. The latter was washed with water and alcohol, and after drying weighed 12.0 grams, preparation **5**. The filtrate from **5** gave only a trace of precipitate on further dialysis.

The preparations were dried to constant weight at 110° and analyzed. The following figures show that fractional precipitation had caused no separation and that the globulin is identical in composition with phaseolin as obtained from the white bean, *Phaseolus vulgaris*.*

PHASEOLIN.

Adzuki bean.

	1	2	3	4	5
Carbon	52.31	52.56	52.74	52.74	52.44
Hydrogen	7.03	6.98	6.94	6.97	6.91
Nitrogen	16.43	16.41	16.34	16.62	16.47
Sulphur	0.57	0.62	0.56	0.49	0.61
Oxygen	23.66	23.43	23.42	23.18	23.57
	100.00	100.00	100.00	100.00	100.00
Ash	0.16	0.73	0.32	0.90	0.05

* Report of this Station for 1893, page 186.

Average. Adzuki bean.	Average. White bean.
52.56	52.58
6.97	6.84
16.45	16.47
0.57	0.56
23.45	23.55
100.00	100.00

The reactions of phaseolin, whether obtained from the common white bean or the adzuki, are as follows :

In cold and warm water it is entirely insoluble.

In sodium chloride solutions it is readily soluble, one per cent. brine dissolving large quantities of phaseolin.

In dilute acids and alkalies it is readily soluble ; the solutions are precipitated by neutralization.

Solutions in dilute nitric or acetic acid are not precipitated even by large excess of acid.

Dissolved in ½ per cent. sodium carbonate solution, phaseolin is precipitated by neutralization, the precipitate being wholly dissolved on adding sodium chloride.

Phaseolin dissolved in ten per cent. sodium chloride brine reacts as follows : It is *not* precipitated even by large excess of hydrochloric, nitric, sulphuric or acetic acids. By a large quantity of trichloracetic acid a precipitate is produced. By dilution with a sufficient quantity of water a precipitate results. Saturation with sodium chloride or magnesium sulphate does not precipitate the phaseolin, but saturation with ammonium sulphate completely throws it out of solution, while saturation with sodium sulphate at 34° precipitates it mostly but not entirely. Potassium ferrocyanide together with a large excess of acetic acid gives a precipitate.

With mercuric chloride dissolved in ten per cent. salt solution, no precipitate is produced. With tannin large precipitates result. With picric acid dissolved in ten per cent. salt solution, no precipitate forms until a considerable quantity of the acid is added, the precipitate thus produced dissolves on adding salt solution.

Phaseolin gives with the biuret, Adamkiewics', Millon's and xanthoproteic tests, the usual proteid reactions.

When solutions in ten per cent. sodium chloride brine are heated, turbidity occurs between 90° and 95° and a small flocculent coagulum separates at 97° to 98°; even prolonged heating

in the boiling water bath coagulates but a small part of this globulin.

The solution filtered from the globulin which had separated on dialyzing the solution of the proteids precipitated by saturating the seed extract with ammonium sulphate was again saturated with this salt and the precipitate thereby produced was dissolved in a small volume of water and, after filtering clear, the solution was dialyzed for six days. Three grams of a dark-colored globulin separated which seemed much contaminated with coloring matter. This was filtered out and the clear filtrate dialyzed five days longer, but no precipitate was obtained. The solution was then dialyzed into alcohol and the precipitate which resulted after drying weighed 8.5 grams. The filtrate contained but a trace of proteid. This substance was ground to a powder, thoroughly exhausted with water, washed with alcohol, dried and found to weigh 7.05 grams. Dried at 110° this preparation, **6**, had the following composition, which it will be noticed is similar to that of preparations obtained in a like manner from the pea, vetch and cow pea.

Adzuki bean.	Pea.		Vetch.	Cow pea.	
6	5	8	20	8	9
53.97	53.33	53.54	53.55	53.13	53.36
7.01	6.98	6.99	6.70	7.09	7.05
16.31	16.14	16.69	16.46	16.51	16.21
0.88	1.00	1.01	1.02	1.09	1.13
21.83	22.55	21.77	22.27	22.18	22.25
100.00	100.00	100.00	100.00	100.00	100.00

Preparation **8**, from the cow pea, was obtained by prolonged dialysis in water, and accordingly must be regarded as a very soluble globulin. Since preparations agreeing well in composition and general properties with it have been similarly obtained from other leguminous seeds by dialysis, it is our opinion that the above analyses represent a distinct globulin which can be only in part removed from its solutions by dialysis in water but is wholly separated, in a coagulated form, by dialysis in alcohol. This globulin is at present being further investigated and it is our intention to offer more respecting its properties in a subsequent paper.

THE AMOUNT AND PROPERTIES OF THE PROTEIDS OF THE MAIZE KERNEL.

By Thomas B. Osborne.

Some time since Prof. R. H. Chittenden and the writer published the results of an extended investigation of the proteids of this seed. (Amer. Chem. Jour., Vol. xiii, pp. 453, 529, and Vol. xiv, p. 20. Abstract in Report of this Station for 1891, p. 136.) In that paper no definite statements were made respecting the quantities of the various proteids found, nor were the properties of some of them as fully described as is now possible. For these reasons the results of some additional researches are here put on record.

The proteids of the maize kernel may be distinguished according to their solubilities as follows:

a. Proteid, soluble in pure water, having some of the properties of proteose.

b. Globulins, insoluble in pure water, but soluble in salt solutions.

c. Proteid, insoluble in water and salt solutions, but soluble in alcohol of 60 to 99 per cent.

d. Proteid matter, insoluble in water, salt solutions and alcohol, but soluble in dilute alkalies and acids.

a. Proteid soluble in Water.

If the substance precipitated from an aqueous extract of yellow corn meal by saturating with ammonium sulphate, is dissolved in water and the resulting solution dialyzed, the globulins extracted from the meal by aid of the soluble mineral constituents of the seed are *largely* precipitated. If these globulins are next *completely* removed by heating the solution to 80° and the filtrate therefrom be precipitated by an excess of alcohol, a small quantity of proteid is obtained having many of the reactions characteristic of proteose. A recent determination showed the presence of only 0.06 per cent. of this body. The quantity found was too small for a satisfactory study of the properties of the substance, but the following observations were made. Dissolved in a little water, only a very small quantity of undissolved substance remained, showing the nearly complete removal of proteid coagulable by alcohol.

The clear filtrate from this insoluble matter when diluted with an equal volume of distilled *water* gave a considerable coagulum on boiling, but when diluted with the same quantity of *ten per cent. salt solution* only an opalescence resulted on boiling. Nitric acid added to the aqueous solution gave a heavy precipitate which nearly all dissolved on warming, with the production of a strong yellow color, and reappeared on cooling. Saturation of its solution with sodium chloride gave a precipitate much increased by the addition of acetic acid, the filtrate from which was not further precipitated on adding nitric acid. The biuret reaction was violet, not rose red, as is usually given by proteoses. This color reaction, however, was probably modified by the color substance associated with the proteid. Sulphate of copper gave with solutions of this proteose only a turbidity. These reactions do not altogether agree with those given by the proteoses which result from the action of enzymes on native proteids. It is possible that future investigation will show that the so-called proteoses found in seeds belong to a different order of proteids from those usually formed by proteolysis.

In the paper already referred to, a substance is described as albumin which was obtained from solutions that were supposed to have been freed from globulin by prolonged dialysis, by adding thereto ten per cent. of sodium chloride and precipitating with very dilute hydrochloric acid. My recent experience in investigating plant proteids has shown that it is extremely difficult and in many cases impossible to completely precipitate all of the very soluble globulins by dialysis, and since the composition of the so-called albumin thus obtained agreed quite closely with that of a very soluble globulin separated from these solutions by prolonged dialysis, and also since the globulin and the so-called albumin coagulated at about the same temperature, I now feel convinced that the two substances are identical, the latter being a part of the globulin which was not precipitated by dialysis. In the former paper attention was called to the fact that this body, in some respects, resembled a globulin more closely than an albumin.

In the former paper were also described, as albumin, coagula obtained by concentrating solutions supposed to have been freed from globulin by dialysis and heating to 100°. It was there suggested that these coagula were probably alteration products of the proteids in solution. Since then "proteoses" from many different seeds have been found to yield coagula under similar

conditions. It seems therefore quite certain that no true albumin exists in the maize kernel.

b. Proteids soluble in Saline Solutions.

If an aqueous extract of yellow corn meal is dialyzed for some time, a proteid, having the properties of a globulin, is precipitated which was found to have the following composition:

MAYSIN.	
Carbon	52.68
Hydrogen	7.02
Nitrogen	16.76
Sulphur	1.30
Oxygen	22.24
	100.00

In our paper on the proteids of this seed, Prof. Chittenden and myself designated this globulin "maize myosin." Further study of plant proteids has shown that no sharp distinction can be drawn between plant myosin and plant vitellin, and I now propose to call this proteid *maysin*, in reference to the specific botanical name *mays*. This globulin readily loses its solubility in saline solutions after precipitation, and therefore the amount present in the seed was underestimated in our former paper. A recent determination in yellow corn meal gave 0.25 per cent.

This proteid is readily soluble in very dilute saline solutions so that it is completely extracted from corn meal by water. Dissolved in ten per cent. sodium chloride brine it is coagulated by heating to 70°.

After separating maysin from the extract of corn meal by dialysis, further prolonged dialysis throws down a small quantity of another globulin having the following composition:

MAIZE GLOBULIN.	
Carbon	52.38
Hydrogen	6.82
Nitrogen	15.25
Sulphur	1.26
Oxygen	24.29
	100.00

This is the globulin which I now think to be identical with the "albumin" which was formerly obtained by precipitation with

salt and acid. This proteid was found in very small amount, 25 kilos of fine meal yielding only 4.1 grams by dialysis and 3.4 grams by precipitation with salt and acid, that is 7.5 grams in all or 0.03 per cent. of the meal. This figure cannot be taken as representing quite accurately the total quantity present, for doubtless some was lost in consequence of the globulin becoming insoluble and some also through incomplete extraction. The total quantity, however, is exceedingly small, probably not more than 0.04 per cent.

Dissolved in ten per cent. sodium chloride solution, this globulin coagulates on heating to 62°.

If yellow corn meal, after thorough extraction with water, is treated with ten per cent. salt solution, a further quantity of globulin is extracted, which is readily precipitated by dialysis in well developed spheroids.

This globulin, formerly designated maize vitellin, agrees in composition and reactions and is, doubtless, identical with edestin which I have found in various seeds.

A recent determination of edestin in the seed of yellow corn showed the presence of but 0.06 per cent. The quantities obtained in the former investigation were 0.06, 0.10 and 0.10 per cent. The composition of this globulin is as follows:

MAIZE EDESTIN.

Carbon	51.43
Hydrogen	6.86
Nitrogen	18.06
Sulphur	0.86
Oxygen	22.79
	100.00

Edestin is much less soluble in saline solutions than the two globulins previously described, and for this reason is readily precipitated by dialysis or dilution. In warm dilute salt solutions it dissolves freely, but on cooling separates more or less completely, according to the temperature and the strength of the salt solution. Dissolved in ten per cent. sodium chloride brine, it is partly coagulated by heating above 90°, but even on boiling the coagulation is far from complete.

c. *Proteid soluble in Dilute Alcohol.*

Finely ground maize meal when extracted by hot alcohol loses 0.8 per cent. of nitrogen, equivalent to 5 per cent. of the character-

istic proteid called maize-fibrin by Ritthausen, but first described by Prof. Gorham of Harvard University, in 1821, and named by him zein. The composition of zein, as shown by the average of nine closely agreeing analyses of as many preparations, is the following:

ZEIN.

Carbon	55.23
Hydrogen	7.26
Nitrogen	16.13
Sulphur	0.60
Oxygen	20.78
	100.00

Zein is in many ways a remarkable proteid. It dissolves abundantly in ethyl alcohol of 0.820 specific gravity, forming solutions which on evaporation in thin layers leave a perfectly transparent sheet of the proteid.

In *absolute* alcohol, as also in water, zein is wholly insoluble, but in mixtures of water and alcohol it dissolves to a greater or less extent, according to the proportions of the two liquids. It is most soluble in alcohol of from 85 to 95 per cent., and dissolves but little in alcohol of less than 50 per cent. Solutions of zein in diluted alcohol deposit the proteid on evaporation as the proportion of water in the solution increases. Strong alcoholic solutions of zein gradually coagulate to transparent jellies, which on long standing become hard and solid. In 95 per cent. methyl alcohol and in commercial propyl alcohol hydrate, zein dissolves readily.

In concentrated glycerin zein is freely soluble on heating to about 150° C., to solutions, which, when much is dissolved, solidify on cooling to 20°. In such solutions zein can be heated to 200° C. without undergoing any apparent change, for, on pouring them into water, the zein separates as a pulverulent precipitate readily and completely soluble in dilute alcohol.

In crystallized phenol, zein is readily soluble on warming, yielding solutions which leave on evaporation clear films of unchanged zein. In glacial acetic acid, zein dissolves in large proportion and is left, by evaporating the acid on a boiling water bath, in transparent films of apparently unchanged proteid, which readily dissolve in alcohol.

Strong solutions of zein in glacial acetic acid when poured rapidly into water give large coherent precipitates which retain

all the original properties of the proteid; if the solution is dilute the zein is to a greater or less extent dissolved by the aqueous acetic acid.

In one-half per cent. sodium carbonate solution and in two-tenths per cent. hydrochloric acid, zein is wholly insoluble even when warmed for 24 hours at 40°.

In $\frac{1}{10}$ to 2.0 per cent. caustic potash solution, zein is very readily dissolved and even by heating to 40° for 24 hours in such solutions is not converted into "alkali-albumin," for the precipitate obtained by neutralizing solutions so treated is completely soluble in alcohol.

Alcoholic solutions of zein are not precipitated by tannin, picric acid, trichloracetic acid, lead acetate, silver nitrate, mercuric chloride, ferric chloride or potassio-mercuric iodide. Clear solutions mixed with silver nitrate dissolved in alcohol leave clear films when evaporated on glass, which gradually turn deep red on exposure to sunlight. When hydrochloric acid in considerable quantity is added to a solution of zein in ethyl alcohol containing much silver nitrate, no precipitate is produced until the mixture has stood for some time, when a turbidity gradually develops which is affected but slowly by light. If the mixture of acid, zein and silver nitrate is boiled it becomes turbid at once.

Zein treated with an alcoholic solution of ferric chloride shows no visible change, but if tested with potassium ferricyanide a deep blue solution is formed, showing that the ferric chloride is reduced at once.

Potassium ferricyanide added to the zein solution is not reduced even after standing some hours.

On digestion with pepsin in hydrochloric acid, zein is converted into proteoses and peptones.*

According to J. G. C. T. Kjeldahl (Bied. Centr. 1896, xxv, 197, from Forhandl. Skand. Naturfors 1892, 385–390) zein dissolved in 75 per cent. alcohol has a specific rotation of $(\alpha)_D - 35°$ and in glacial acetic acid $(\alpha)_D - 28°$.

d. Proteid matter soluble in Alkalies.

This was estimated as follows. One hundred grams of very finely ground maize meal which contained 1.54 grams of nitrogen were successively exhausted with two-tenths per cent. potash water and with alcohol. The dried residue weighed 77 grams

* Chittenden, Medical Record, xlv, 487.

and contained 0.1645 grams of nitrogen. Accordingly 1.3755 grams of nitrogen, including that of all the soluble proteids, had been extracted. This amount multiplied by the factor 6.25 gives the total quantity of soluble proteids, viz., 8.5969 grams. Subtracting therefrom the sum of the several proteids previously determined, viz., zein 5 grams, globulins 0.39 grams and proteose 0.06 grams, there remains 3.1469 grams of proteid insoluble in salt solutions and alcohol, but soluble in dilute potash water.

The alkaline extract obtained in estimating the quantity of this proteid was filtered perfectly clear, neutralized with acetic acid, the precipitate filtered out, washed thoroughly with water and extracted with hot alcohol to remove zein.

The proteid residue was then redissolved in dilute potash water, filtered clear and again precipitated by neutralization with acetic acid and thoroughly washed with water, with hot alcohol and finally with ether. After drying at 110° the preparation was analyzed with the following results:

Carbon	51.26
Hydrogen	6.72
Nitrogen	15.82
Sulphur	0.90
Oxygen	25.30
	100.00
Ash	2.38

The results of this analysis do not indicate that this substance has any relation to the other proteids already described. Owing to its insolubility in neutral fluids no characteristic reactions could be obtained, and accordingly nothing more was learned respecting it.

The foregoing statements show that 100 grams of the yellow corn meal contained approximately:

Proteid soluble in $\frac{2}{10}$ per cent. potash	3.15	grams	containing	15.82	per	cent.	N.	= 0.4983	grams.
Zein	5.00	"	"	16.13	"	"	"	= 0.8065	"
Very soluble globulin	0.04	"	"	15.25	"	"	"	= 0.0061	"
Edestin	0.10	"	"	18.10	"	"	"	= 0.0181	"
Maysin	0.25	"	"	16.70	"	"	"	= 0.0417	"
Proteose	0.06	"	"	17.00	"	"	"	= 0.0102	"
								1.3809	"
Nitrogen undissolved by dilute potash water								0.1645	"
Total								1.5454	
Nitrogen in meal by analysis								1.5400	
Mean percentage of nitrogen in Maize Proteids								16.057	

INDEX.

3

State of Connecticut.

Ninth Annual Report

of the

Storrs

Agricultural Experiment Station,

Storrs, Conn.

1896.

Printed by Order of the General Assembly.

MIDDLETOWN, CONN.:
PELTON & KING, PRINTERS AND BOOKBINDERS.
1897.

PUBLICATIONS OF THE STATION.

The publications of the Station will be mailed to all citizens of Connecticut, and to Granges, Farmers' Clubs, and other agricultural organizations who ask for them, and so far as circumstances permit, to those who apply from other States. Requests for publications should be addressed to

STORRS AGRICULTURAL
EXPERIMENT STATION,

TOLLAND COUNTY. STORRS, CONN.

CONTENTS.

OFFICERS OF THE STATION.

EXECUTIVE COMMITTEE.

T. S. Gold, West Cornwall, J. M. Hubbard, Middletown,	*Of the Board of Trustees of Storrs Agricultural College.*
B. F. Koons, Storrs,	*President of the College.*

TREASURER.

Henry C. Miles, Milford.

STATION STAFF.

W. O. Atwater,	*Director.*
C. S. Phelps,	*Vice-Director and Agriculturist.*
James S. Judd,	*Secretary.*
Francis G. Benedict,	*Chemist.*
W. L. Pentecost,	*Assistant Agriculturist.*
William J. Karslake,	*Assistant Chemist.*

The Station is located at Mansfield (P. O. Storrs), as a department of the Storrs Agricultural College. The chemical and other more abstract research is carried out at Wesleyan University, Middletown, where the Director may be addressed.

Report of the Executive Committee.

To His Excellency Lorrin A. Cooke,
Governor of Connecticut:

In accordance with the resolution of the General Assembly concerning the congressional appropriations to Agricultural Experiment Stations, and an Act of the General Assembly approved March 19, 1895, relating to the publication of the Reports of the Storrs Agricultural Experiment Station, we have the honor to present herewith the Ninth Annual Report of that Station, namely, that for the year 1896.

The accompanying report of the Treasurer gives the details of receipts and expenditures. We refer you to the report of the Director and his associates for a statement of the work accomplished during the past year. We are confident that the funds have been wisely expended and that the work accomplished is such as will result in great benefit to our agricultural and other interests.

Mr. Chas. D. Woods, Vice-Director of the Station, resigned his position July 1, 1896, to accept that of Professor of Agriculture and Director of the Experiment Station of the Maine State College. Professor Woods has been connected with the Storrs Station since a short time after its organization. His services have been most valuable and highly appreciated. While the Executive Committee share with the other friends of experiment stations in Connecticut the sense of the loss to our State, they are at the same time glad that the field of labor to which he has been called should be one of so large usefulness and honor.

Respectfully submitted,

T. S. GOLD,
J. M. HUBBARD,
B. F. KOONS,
Executive Committee.

Report of the Treasurer

FOR THE FISCAL YEAR ENDING JUNE 30, 1896.

The following summary of receipts and expenditures, made out in accordance with the form recommended by the United States Department of Agriculture, includes, first, the Government appropriation of $7,500, and, secondly, the annual appropriation of $1,800 made by the State of Connecticut, together with various supplemental receipts. These accounts have been duly audited according to law.

GOVERNMENT APPROPRIATION—RECEIPTS AND EXPENDITURES.

RECEIPTS.	
United States Treasury,	$7,500 00
EXPENDITURES.	
Salaries,	$4,844 96
Labor,	482 09
Publications,	183 20
Postage and stationery,	331 28
Freight and express,	111 50
Heat, light, and water,	352 97
Chemical supplies,	367 42
Seeds, plants, and sundry supplies,	53 38
Fertilizers,	105 48
Feeding stuffs,	122 66
Tools, implements, and machinery,	22 85
Furniture and fixtures,	87 83
Live stock,	179 12
Traveling expenses,	164 46
Contingent expenses,	10 00
Building and repairs,	80 80
Total,	$7,500 00

STATE APPROPRIATION AND SUPPLEMENTAL RECEIPTS—RECEIPTS AND EXPENDITURES.

RECEIPTS.	
State of Connecticut,	$1,800 00
Sale of produce,	52 10
Miscellaneous receipts, including sale of apparatus,	762 49
Total,	$2,614 59
EXPENDITURES.	
Salaries,	$902 38
Labor,	211 11
Chemical supplies,	115 77
Bacteriological investigations,	400 00
Seeds, plants, and sundry supplies,	233 76
Fertilizers,	88 89
Furniture and fixtures,	22 37
Scientific apparatus,	640 31
Total,	$2,614 59

HENRY C. MILES, *Treasurer.*

Report of the Director for the Year 1896.

The principal subjects of inquiry and lines followed during the past year may be concisely stated as follows:

METEOROLOGICAL OBSERVATIONS.

These have been continued during the past year, as previously, at Storrs, where records have been made of temperature, barometric pressure, wind velocity, humidity, rainfall, and snowfall. In addition, records of rainfall during the growing season have been made in other places in the State by farmers who have coöperated with the Station.

IRRIGATION.

A new line of experimenting was undertaken in 1895, in the form of tests of the effects of irrigation upon the production of strawberries. The work was done in coöperation with one of the prominent strawberry growers of the State, Mr. J. C. Eddy, of Simsbury, Conn., upon his own fields. The results were very successful and tend to confirm the impression that irrigation, not only of small fruits, but of other crops as well, may prove a much greater aid in their cultivation than has heretofore been supposed.

Owing to severe winter killing of the plants, and to large rainfall during the strawberry season, these experiments were of little value the last year. It is hoped to continue them, however, another season.

FIELD EXPERIMENTS.

These have been with fertilizers and with forage plants.

The experiments with fertilizers have been conducted mainly at the Station. Their object has been to study the influence of the different materials upon the amount and the feeding value of the crop; especially the influence of nitrogenous fertilizers upon the protein of the crop. The results indicate more and more clearly the advantage of nitrogen in fertilizers for grasses and cereals, and the bad economy of its use for legumes.

The experiments with forage plants have been practical tests of the growth of the crops in the field and the milk production when the fodder is eaten by cows. Here, again, the advantage of diversified forage crops to supplement pasture feed in Connecticut is brought out more and more clearly and fully with each year's experience.

BACTERIOLOGY OF DAIRY PRODUCTS.

The work on the bacteriology of dairy products has been continued during the past year by Prof. Conn and his assistant, Mr. Esten. It has been devoted mainly to the further investigation of the important subject of cream ripening. This part of the process of butter-making is now known to be one of fermentation, produced by the bacteria in the cream. These bacteria come from various sources in the dairy and the barn. The especial object of the experiments of the last year has been to get light upon the kinds of bacteria that are common in Connecticut dairies, their sources, and the influence they exert upon butter when they chance to get into the cream and grow during the ripening process. It is hoped that the investigations in this direction will bring information that will materially aid the butter-maker to exercise a better control over this important phase of his industry than he has been able to do in the past.

FOOD AND NUTRITION OF DOMESTIC ANIMALS.

The investigations have included: Analyses of feeding stuffs with determination of their fuel value; Studies of rations fed to milch cows on dairy farms: Digestion experiments with sheep.

The analyses of feeding stuffs have been largely in connection with the feeding experiments with cows and sheep. Analyses have also been made of plants and crops grown on plots of land receiving different amounts and kinds of fertilizers. The number of analyses of feeding stuffs during the year is not far from one hundred and fifty.

The studies of rations fed to milch cows have been carried out on two dairy farms. The methods were like those followed in previous years. A representative of the Station visited each farm. A certain number of cows (about a dozen) were set aside for the experiment, which continued, in each case, from

four to twelve days. All the fodder of each kind fed the cows during the period and the milk given by each cow was weighed. Samples of the feeding stuffs were taken and sent to the Station for analysis, and the amount of fat in the milk was ascertained by the Babcock test on the ground. The results of these observations accord with and confirm still more strongly the doctrine which the Station has maintained — that most Connecticut farmers feed too wide a ration to their cows; that is, the feeding stuffs contain relatively too little nitrogenous matter.

It is worthy of note, however, that one of the farmers visited this year was feeding a ration as high in protein as that proposed by the Station and even higher, yet when this ration was made still more nitrogenous, the result, so far as the short experiment indicated, was pecuniarily profitable.

Such information as is obtained in these experiments has an especial value to other farmers; being the fruit of the actual experience of one of their fellow-workers, it has a meaning for them which it would not have if it came only from the Station. At the same time the Station experimenters reap a benefit from the direct work with the farmer, in that they learn better what are his wants and how to meet them. This coöperation between the Station and the practical farmer is a means of making direct practical application of the results of scientific research; it brings new information, and it is one of the most effective means for the dissemination of knowledge. Thus, in a three-fold way, it benefits the public, which the Station is endeavoring to serve.

The digestion experiments with sheep are similar to those previously reported. Their object is to learn what proportions of the nutritive ingredients of different feeding stuffs are actually digestible. As the results of such experimenting in Europe and in this country accumulate it becomes more and more probable that the different ruminants, as cows, oxen, sheep, and goats, digest very nearly the same amounts of protein, carbohydrates, and other nutritive ingredients from the same kinds of feeding stuffs. Hence the experiments on the digestion of different materials by sheep may be taken as an approximate measure of the digestibility of the same materials by milch cows. The greater convenience of handling sheep in

such experiments is the reason for using them instead of cows for testing the digestibility of some of the feeding stuffs of importance in the State. The experiments of the past year have been chiefly with green fodders and hays. In two cases milling products were fed in addition to the hay.

FOOD AND NUTRITION OF MAN.

The inquiries under this subject have been conducted for the most part in coöperation with the United States Department of Agriculture. They have included: Analyses of food materials; Studies of dietaries of families; Experiments upon the loss of nutritive material from potatoes when they are cooked in different ways; Digestion experiments with men; Experiments with men in the respiration calorimeter.

Analyses.—Not far from fifty analyses of specimens of articles used for the food of man have been made in connection with the dietary, digestion, and respiration experiments.

The experiments on the cooking of potatoes were intended to get light on the amounts of nutriment which are lost from potatoes in boiling in different ways. When boiled with the skins on the loss was too small to be of consequence, but when boiled with the skins off the loss was quite considerable.

The dietary studies are made by weighing, measuring, and analyzing the food purchased and consumed by a given number of people—a family for instance—during a certain number of days, and noting how the amounts and nutritive ingredients of the food compare with physiological standards, and how the actual cost compares with what the same amount of nutriment would have cost in more economical forms. The present Report includes studies of three dietaries of farmers' families, one of the Station agriculturist's family, two of poor families in Hartford, and three others which can be assigned to no particular class. These studies as they accumulate are useful, not only in bringing out the peculiarities of dietary usage of the different families, their methods of purchase and preparation of foods, the amounts of food wasted, and the ways in which improvements could be made to the advantage of both health and purse, but also in throwing light upon the general habits of living of people of various classes, such as farmers, mechanics, and those in business and professional life. The

food of people of the poorer classes is also being made a subject of study with results that are likewise extremely interesting.

Digestion Experiments.—A large number of experiments have been made in Europe, and of late in this country, to test the digestibility of various feeding stuffs by domestic animals. It is certainly as desirable to understand the digestibility of the food used by man as that of feeding stuffs used by domestic animals. Within a few years past a considerable number of digestion experiments with men, and some with children, have been made in European laboratories. In connection with the series of food investigations to which those carried on by the Storrs Station belong, such experiments have been undertaken in several institutions in this country. A considerable number have been carried out in connection with the Storrs Station during the past two years.

Twelve such experiments made with healthy men, by the Station alone or in coöperation with the Department of Agriculture, are described in the present Report. The method followed in these experiments is similar to that used in the tests of the digestibility of feeding stuffs by animals. It consists in weighing and analyzing both the food eaten and the undigested residue, and thus obtaining a measure of the proportions of the different nutritive ingredients of the food actually digested by the persons under experiment.

Compilation of the Results of Analyses and of Experiments on Digestibility of Foods.—In the Report of this Station for 1891, tables were given showing the results of analyses of American food materials. These included several hundred analyses of which the larger part had been made by the writer and his associates. Since that time the number of analyses has rapidly increased. A compilation lately made in behalf of the Office of Experiment Stations of the United States Department of Agriculture includes analyses of nearly 3,000 specimens of animal and vegetable food materials. This compilation is intended to include all of the analyses of such products that could be found up to July 1, 1896, exclusive of dairy products, sugars, and some other materials of which the number of analyses, especially for commercial purposes, is large, and the

results are so difficult to obtain as to make a complete compilation difficult, as indeed it is unnecessary. Of the analyses thus compiled not far from 1,300 have been made by the writer and his associates, and not far from 700 by others in connection with the series of coöperative food investigations now being conducted under the auspices of the Department of Agriculture. The larger number of the rest were by the Division of Chemistry of the United States Department of Agriculture, which has also made great numbers of analyses of the classes of food materials of which the complete compilation was not attempted for the reason just stated.

We have thus to-day a reasonably fair idea of the chemical composition of the food materials most commonly used in the United States. Their nutritive value, however, depends upon not only the proportions of the different nutrients—protein, fats, carbohydrates, etc.—but also upon the amounts of those nutrients which can be actually digested and used by the body for its nourishment. The object of the digestion experiments above referred to is to get light upon this latter factor—that of the nutritive value.

Another factor of the value of food for nourishment is what is called the fuel value; *i. e.*, the amount of potential energy in the food which can be transferred in the body into heat, muscular power, or other forms of energy.

Table of Percentages of Digestible Nutrients and Fuel Values of Foods.—While the information on these latter and kindred subjects now available is far from sufficient to show the exact values of different kinds of food for the nourishment of the body, enough has already accumulated to warrant the preparation of a reference table giving the estimated average amounts of actual digestible nutrients in a number of the materials most commonly used for the nutrition of man. Such a table has been prepared and is printed in the present Report. As explained in the description which accompanies this table, the figures are not given as showing exactly the average composition, digestibility, and nutritive value of each class of food materials. Many more analyses and experiments will be needed to show the range of variation and the actual averages of both composition and digestibility. The estimates of fuel

values likewise are only approximations. Much more experimenting will also be needed to show, as accurately as we need to know, just how the different ingredients of the several classes of food materials are used in the body, and just what are the requirements of people in different classes, and under different conditions, for proper nourishment. When, however, we consider that, twelve years ago, we had extremely little accurate information about the chemical composition and nutritive values of American food materials, and were obliged to look to European sources for nearly all of our information upon these subjects, and to depend upon analyses of European products for estimates of the composition of food materials produced in this country, the fact that such a table can be prepared from data which has been accumulated mostly in this country during so short a period is, most assuredly, a cheering mark of progress.

Heats of Combustion and Fuel Values of Foods and Feeding Stuffs.—In all the foods and feeding stuffs analyzed during the past year, the heats of combustion, which are taken as measures of the fuel value, have been determined by the bomb calorimeter. An account of this apparatus was given in the Annual Report for 1894. It has since been further elaborated, and is now being made for other institutions, several of which already have it use.

Experiments with Men in the Respiration Calorimeter.—Previous annual reports have contained brief reference to this apparatus, which has been for some time in process of development. As was there explained, the more purely scientific purpose is the study of the application of the laws of the conservation of matter and energy in the living organism. At the same time it has a most intensely practical purpose, namely, to learn more of the laws of nutrition and the ways the food is used in the body. To obtain this most useful knowledge, abstract research of the highest order is necessary.

The experiments are made by placing a man inside a box or chamber under conditions which permit the measurement of the income and outgo of his body. Arrangements are made for ventilating the chamber by a current of air which is measured and is analyzed as it goes in and comes out, so that the

products of respiration are determined. In this respect the apparatus is similar to those which are used in a number of places for experiments on the income and outgo (metabolism) of matter, and to which the name respiration apparatus is commonly given. Provision is also made for weighing and analyzing all the food and drink, and the solid and liquid excreta as well. By comparing the chemical elements and compounds received by the body in food, drink, and exhaled air with those given off in the solid and liquid forms by the intestines and kidneys, and in the form of carbonic acid gas, water, vapor, and otherwise by respiration and perspiration through the lungs and skin, we are enabled to strike a balance between the total income and outgo of matter in the man's body. We thus measure, on the one hand, the total food and drink consumed, their ingredients, the proportions of the several nutrients actually digested and taken into the blood to be used, and on the other, the quantities of material given off from the body during the period of the experiment. These data, taken in connection with what is known of the physiological processes that go on in the body, give more accurate information than can otherwise be obtained regarding the ways in which the food is used, and the quantities of different food ingredients that are needed to supply the demands of the body for various purposes of work and rest. Experiments of this kind are commonly known as respiration experiments.

The experiments, as above described, show the balance of income and outgo of chemical elements and compounds, and serve for the study of the metabolism of material in the body. It is desirable, however, to study the metabolism of energy. To this end it is necessary to know the potential energy of the food and drink, on the one hand, and, on the other, the potential energy of the excreta and the amounts of energy given off in the form of heat, external muscular work, and otherwise. The measurements of the potential energy of the food and excreta are made with the bomb calorimeter. The determination of the heat given off from the body is attempted by certain arrangements connected with the respiration apparatus, which have led to the use of the term respiration calorimeter. The accurate measurement of the heat is a matter which presents numerous difficulties. It appears, however, that these have

been for the most part overcome, and the prospect for final success seems very good.

Meanwhile a number of respiration experiments have been made and are described in some detail in the present Report. In each one, the subject, a man, remained in the apparatus from fifty-four hours to twelve days. The results show very clearly the gain or loss of protein and fat in the body with different kinds and amounts of food and under different conditions of work and rest. The success with these experiments has been very gratifying, and the promise for the future is, at present, even more so.

The full details of these experiments have been transmitted to the Department of Agriculture for publication, and it is hence deemed necessary to give only the principal results in the present Report.

STATE APPROPRIATION FOR INVESTIGATION OF FOOD ECONOMY.

The General Assembly at its last session provided an annual appropriation of $1,800 for the Storrs Station, to be used "for the purpose of investigating the economy of the food and nutrition of man, and for investigations of the bacteria of milk, butter, and cheese, and their effect in dairying." With this very material help the Station is able to greatly increase the amount and value of its inquiries in these directions.

GOVERNMENT COÖPERATION IN FOOD INVESTIGATIONS.

Among the numerous objects of agriculture the chief is the production of food for man. That the experiment stations in the country have hitherto studied the soil, the plant, and the animal, and their food and nutrition, and have given but little attention to the food of man, is not the fault of the stations. It is due simply to the fact that the primary purpose has been to help the farmer to improve his farming rather than to help the people at large to improve their food economy. It was for this reason that the original Act of Congress providing for experiment stations in all of the States and Territories did not include experiments upon the food and nutrition of man as a part of the work which it called upon the stations to perform. In 1894, however, the legislation with reference to the stations was so changed by Congress as to specifically authorize inquiries of this latter kind. At the same time an appropriation of $10,000

was made for the fiscal year ending June 30, 1895, to promote especial inquiry into the food economy of the people of the United States. The appropriation has been increased in the succeeding years to $15,000. The general government has thus formally recognized the important fact that the food of the people of this country for which wage workers spend half their income and upon which our health and capacity for work so intimately depend, is as proper a subject for experimental study as the food of the farmers' crops and cattle.

The responsibility for the expenditure of the Government appropriation referred to is given by Congress to the Secretary of Agriculture, who has assigned the inquiry to the Office of Experiment Stations. The conditions of the Act of Congress are such as to favor coöperation between the Department and other institutions of research, especially the experiment stations in different parts of the country. Accordingly, while a part of the work is done under the immediate direction of the Department, a considerable portion is being carried out in coöperation with experiment stations, colleges, and other organizations, including the Storrs Station, to whose Director the immediate charge of the enterprise is entrusted.

At present all of the food investigations of the Station are being conducted in coöperation with the general government, by which a considerable share of the expense is paid. By such coöperation a much larger amount of research is being carried on by the Station than the State appropriation provides for, and, at the same time, the contribution by this State to the enterprise is made much more fully available to the country at large. There is a like coöperation in the publication of the results of the inquiry. In this way the practical results of the work of the Station are made available to the citizens of the State, through the Station Reports and Bulletins, while much of the more technical details which are of decided scientific importance, but of less special interest to farmers and the public at large, are published by the general government.

W. O. ATWATER,
Director.

BACTERIA IN THE DAIRY.

XI.—FURTHER EXPERIMENTS IN CREAM RIPENING—FLAVOR, AROMA, ACID.

BY H. W. CONN, PH. D.

During the past few years the problem of cream ripening has been forcing itself more and more upon the attention of butter-makers. The objects of ripening cream are to make churning easier, to increase the yield of butter, and improve its flavor and aroma. The first two purposes have been discussed in Bulletins of this Station.* It has been known for some years that the flavor, the aroma, and the acid which are produced in cream during its ripening, and which give the peculiar character to the butter made therefrom, are due to the growth of bacteria in the cream. The real source, however, of the flavor is the cream itself, and the quality of the cream undoubtedly affects the character of the flavor. But in order to develop the proper flavor this cream must undergo certain chemical changes, and these changes are brought about by bacteria, which multiply in the cream with incredible rapidity during the ripening process. Experiments hitherto have been largely confined to a few selected species of bacteria, and we have had very little knowledge in regard to the effect produced upon the butter by the many different species of bacteria commonly found in milk and cream.

ACID, FLAVOR, AROMA.

It has been found that ripening is practically always accompanied by a souring of the cream, so much so that in most

* Some of the results have been given in the publications of the Station, as follows: *Bacteria in Milk, Cream, and Butter*, Bulletin 4 and Annual Report for 1889, pp. 52 67. *Ripening of Cream*, Annual Report for 1890, pp. 136-167. *A Micrococcus of Bitter Milk*, Report for 1891, pp. 158–162. *The Isolation of Rennet from Bacteria Cultures*, Report for 1892, pp. 106–126. *The Ripening of Cream by Artificial Cultures of Bacteria*, Bulletin 12 and Report for 1893, pp. 43–68. *Experiments in Ripening Cream with Bacillus No. 41*, Annual Report for 1894, pp. 57-68. *Some Observations of the Number of Bacteria in Dairy Products*, Annual Report for 1894, pp. 69–77. *Cream Ripening with Pure Cultures of Bacteria*, Annual Report for 1894, pp. 77-91. *A Year's Experience with Bacillus No. 41 in General Dairying*, Annual Report for 1895, Part I., pp. 17–40. See also *The Fermentations of Milk*, Experiment Station Bulletin No. 9 of the Office of Experiment Stations of the United States Department of Agriculture.

parts of the world it is called "cream souring." It has been found that good flavors are especially developed by the acid-forming species of bacteria. It has been assumed, therefore, that the development of flavor and the development of acid are essentially identical, or at least necessarily associated. Some practical, as well as scientific, butter-makers are teaching that one essential point to be aimed at in the cream ripening is to cause the acid-producing organisms to grow rapidly in order to develop an acid and flavor before the other organisms have a chance to increase. The fact that the extent of the ripening is determined by the amount of acidity conveys the impression that the ripening and the souring are identical. The idea was advanced by myself, however, some years ago, that flavor production is independent of acid production, and while many of the acid-producing species also produce changes in the cream which give rise to a good flavor, equally good flavors may be obtained by species of bacteria that produce no acid, and that some species of bacteria may produce acid in abundance without giving rise to the proper flavor. This conclusion was also reached by other bacteriologists. Storch, who first worked with pure bacteria cultures for cream ripening, found some species producing acid but not good flavor, and the same results were reached by Weigmann.

The relation of ripening to the aroma of butter is also an uncertain one. There are several pure cultures used in different dairying countries for artificially ripening cream, most of which produce favorable results so far as concerns acids and flavors, but none of which appears to give a satisfactory aroma.

Each of these three factors seems to be essential to a proper cream ripening, and we cannot hope to satisfactorily control this ripening until we know how and under what condition flavor, acid, and aroma are produced. Plainly, if we find that all three are produced by the same conditions and by the same species of bacteria, our method of handling cream for butter-making will be determined by this fact; while if we find that they are produced by different and independent agencies, the method of handling cream must be different.

The final settlement of these questions can only be reached after a long series of experiments. To determine accurately the relation of flavor and aroma to bacterial growth it has

appeared to me to be necessary to experiment, not with one or two, or with half a dozen, species, as has been generally done by bacteriologists hitherto, but with as large a number of the species of dairy bacteria as is possible. For two years or more I have been engaged in testing the effect upon cream ripening of the various kinds of bacteria which have been found in milk and cream. Some of these experiments have been reported in earlier publications. The present series began in May, 1895. In this work I have been assisted by Mr. William Esten, who has carried out a large portion of the practical experiments.

BACTERIA OF ORDINARY CREAM.

The first task in this series of experiments was to collect from creameries and from dairies a large variety of bacteria. It was especially desirable to obtain those found in creameries during the months of May and June, inasmuch as these months are commonly characterized by the production of the best quality of butter. During May and June of 1895 quite a number of visits were made to creameries in Connecticut, including those at Cromwell, Durham, Wapping, Elmwood, Farmington, and Ellington. Some of these creameries were visited two or three times, others only once. From the cream thus obtained as many different species of bacteria as possible were taken at once and set aside for future work. At subsequent periods other visits have been made to the same places. Other samples of milk and cream have been obtained from dairies at Storrs, and from two or three different dairies in Middletown. From these various sources nearly one hundred different types of bacteria have been obtained, most of which have been carefully studied and tested in cream ripening.

In thus describing them as different types I would not imply that they are necessarily different species, but simply that they show some differences in their method of growth. Bacteriologists do not yet know what constitutes a species among these organisms, and it is extremely probable that some of the hundred referred to really belong to the same species of bacteria, some of them being only slight variations of others. They all produce different effects, and have consequently been studied independently of each other. All of the general types of milk bacteria are included among this list. It includes some

bacteria which sour milk by producing lactic acid, others which curdle the milk by producing a rennet-like ferment, but rendering the milk alkaline, others, again, which exert a putrefactive effect upon the milk, and still others that have seemingly no effect whatsoever upon the milk or cream. The various types were in almost equal abundance among the species collected, except that the number of forms that have no appreciable effect upon milk is considerably larger than those belonging to any of the other classes.

In the early summer the variety of bacteria in the cream has been found to be greater than at the other seasons of the year thus far tested. No examinations have yet been made of the cream of the late summer or early fall. In nearly all of the samples of cream collected in May, and particularly in June, the number of different species was very great, not only when different samples were compared with each other, but in the same sample of cream. This would naturally have been anticipated, and is probably closely associated with the green food of the cows. It appears not unlikely that in this fact lies the explanation of the high quality of butter flavor commonly developed during these months. Not only is the variety greater, but the number of bacteria in the cream during these months is vastly in excess of that found under similar conditions in the cooler months of the year. No accurate quantitative tests were made, but the difference in the number of bacteria found in the samples of cream tested in June and those tested in February was very great indeed, even though the age of the cream was the same in the two cases. This fact is, of course, due to the temperature which stimulates bacterial growth.

Another point in the same connection is the difference in the species of bacteria found at the same creamery at different times. Such samples, even though following each other at short intervals, showed a considerable difference in the types of bacteria found. This is in part due to the fact that no bacteriological examination of cream can disclose all of the kinds of bacteria therein, and the bacteriological analysis is, therefore, in every case, very incomplete. Two samples of the same cream would doubtless show some differences for this reason. But this is not wholly the explanation of the matter,

since it was frequently found that a sample of cream taken at one date would disclose a large number of bacteria which liquefied gelatine, while another taken a few days later would show no liquefying bacteria. The presence of the liquefying organisms is most easily determined; in fact one can never fail to detect them. Their presence in quantity in some cases, and their absence in others is, therefore, significant.

Variation with the Cow.—One series of experiments consisted in the testing of the milk from eight cows in the same barn. These cows were kept in adjoining stalls and fed in the same manner, and their milk was drawn into sterilized bottles and then tested separately. After a few weeks the same eight cows were again tested in the same way, and the same test was repeated at short intervals for several months. It was found in these tests that there was the most striking difference between the bacteria in the milk of the separate cows. The *number* varied surprisingly. The milk from two of the cows contained not more than 250 bacteria per loop full (a loop full is a drop about the size of the head of a large pin), while the milk from a third, contained 20,000, and a fourth, 60,000, in the same quantity of milk. The *variety* of bacteria was no less interesting. In the first place, it was found that no two of these eight samples of milk, when left to themselves and carefully guarded from outside contamination, underwent the same kind of fermentation. Some of them curdled and soured, some of them curdled without souring, some developed a cheesy odor, others a putrefactive odor, and, among the lot, there was one cow that gave milk that became slimy. When the same cows were tested a second time, a few weeks later, the effects were different. The cow that previously gave slimy milk, no longer produced milk with this defect, and all of the samples but one soured, although not in the same way in any two cases. In the third test still other variations occurred. When the bacteria from the eight samples were studied, it was found, as was to be expected, that there was a good deal of variation. There were one or two species that were common to nearly all of the cows, while others were found in one lot of milk, and others, again, in one or two lots. It must be always kept in mind that these bacteria of which we are now speaking do not come

from within the milk gland, but only from the milk ducts. They do not, therefore, come from within the animal, but really from the exterior. They are bacteria from external sources, which have made their way into the ducts, and not bacteria from within the animal making their way out. This difference in the bacterial flora of milk from cows in the same barn is certainly a somewhat surprising and interesting fact. It gives us a suggestion as to the complex mixture of bacteria in cream of an ordinary creamery coming from hundreds of cows. It shows further how impossible it must be to obtain a uniform quality of cream (so far as bacteria are concerned) from many contributing sources.

METHOD OF EXPERIMENT.

The method of experiment has been to separate a lot of cream from the milk by a centrifugal machine and then divide it into four equal parts. In more recent experiments a larger amount of cream was taken and eight experiments were carried parallel with each other. All of the cream was heated to a temperature of 69°–70° C. (156°–158° F.) for fifteen minutes and then allowed to cool. This heating (pasteurizing) destroyed most of the bacteria which chanced to be present in the cream, only such bacteria as produce spores remaining alive. Experience has shown that such heating will kill all the lactic bacteria.

The species of bacterium to be tested was grown in sterilized milk. Two days before the experiment began a sufficient number of vessels of sterilized milk were inoculated, each with a different species of bacterium. These were then allowed to grow for two days. When the lots of cream were pasteurized and cooled, as above described, one of these milk starters was poured into each. Each of the lot received a starter made from a different species of bacterium, and one lot was always left for a control experiment without any starter.

The four samples were then placed under similar conditions as to temperature and allowed to ripen for the same length of time. After considerable experience it was found that the most satisfactory method of procedure was to use a ripening of forty-eight hours at a somewhat high temperature (about 21° C., 70° F.). After the ripening the cream was cooled and

churned. The examination of the butter was made, in most cases, without salting, inasmuch as salting very commonly obscures the peculiar flavors developed during the ripening process. The testing was made for flavor, for acid, and for aroma. In the records that were kept it was difficult in many cases to know exactly how to describe the flavor or aroma of a lot of butter. The flavors and odors that develop as a result of the ripening of different species of bacteria are highly variable, and the words in our language for the description of either flavors or odors are entirely inadequate to any considerable accuracy. Inasmuch, however, as the problem was chiefly to determine the relation to butter-making, the record was made from this standpoint, and the butter was described either as possessing a good, a bad, or an indifferent flavor, or as having a typical, or an unusual aroma, or no aroma. It must be recognized also that tastes differ, and a flavor which has appeared to me to be good might not always so appear to others. While, therefore, the classification is not as accurate as might be scientifically desired, it is sufficiently accurate for determining the relation of the various bacteria to butter-making and to the normal flavor and aroma.

It will be evident from this description of the method of experiment that the tests have always been made in very small lots of cream. There are some decided advantages and some decided disadvantages in this method. The disadvantage is in the fact that tests in such small lots cannot be relied upon to produce very good results or truly normal butter. First-class butter, as is well known, cannot be made without attending very strictly to all conditions, and manifestly when butter is made in lots of half a pound or so it is impossible to control the results satisfactorily. On the other hand, however, it is a far easier matter to compare results obtained by different species of bacteria if they can be directly compared with each other. When we have six or more samples of butter made from the same lot of cream, and under identical conditions, except that the species of bacteria used in ripening is different, a comparison between the flavors and aromas is more valuable than if these tests were made upon different days from different lots of cream. Inasmuch as these experiments were designed to test the general effects of many species rather than

to find out the particular species which produced the best butter, I have thought that this method of testing several species simultaneously promised the most valuable results.

RESULTS.

In general the results of these experiments have been confirmatory of those of the series already given in a previous publication (Bulletin No. 12). Nevertheless, a number of new facts of interest and importance have appeared. The most important of these results are the following:

CONTROL CREAM COMPARED WITH INOCULATED CREAM.

First.—One of the most interesting facts was found in comparing the control (*i. e.*, the pasteurized but not inoculated) samples of cream, and butter made therefrom with the inoculated samples. As a rule the control butter possessed neither flavor nor aroma—in no case unless the ripening had continued too long. Nevertheless, it was found in many cases that the control cream *did* undergo some decided changes during the period of ripening. The temperature of 158° F. (used in pasteurizing) does not kill all the bacteria in the cream, and the subsequent ripening being somewhat long and the temperature somewhat high, the few bacteria that were left in the cream after pasteurization had an opportunity to develop. The cream thus frequently showed the effects of their presence. In many cases the control cream was thick and nearly curdled, but inasmuch as it was never acid, it was plain that this effect was due, not to the lactic acid organisms, but rather to the growth of the species of bacteria which curdle milk by the production of a rennet ferment; a class frequently called the putrefactive class of bacteria. This is readily understood, since these bacteria frequently produce spores which resist heat, while the acid bacteria produce no spores. In a few cases the control cream became slightly bitter or developed some other unusual taste, but the taste was so slight that it had no effect upon the butter made from the cream. These facts, of course, are not surprising, for they are exactly what would have been expected when we remember that pasteurization does not destroy all the bacteria present in the cream. The interesting fact in these experiments was that in no case did the inoculated lots of cream show similar results. Where the control cream

became bitter none of the three inoculated samples showed the slightest trace of bitterness. Where the control cream showed a partial curdling, the inoculated samples showed an entirely independent effect that was evidently due directly to the influence of the inoculated species and not to those left in the cream after pasteurizing. In some cases the inoculated cream was thickened and curdled from the effects of the bacteria with which it had been inoculated, but, in other cases, where the inoculated species had no power of curdling the cream, the cream at the end of the ripening was as thin as at the beginning, showing no trace of curdling even though the control cream was at the same time very thick. These results were not in one or two cases, but in a great number of experiments. The result at first surprised me, but it was found to be so general that I soon came to look upon it as normal and to expect it.

WHY "STARTERS" ARE BENEFICIAL.

The importance and significance of this fact is considerable. If the control develops a bitter taste, while the inoculated species does not, this can only be because certain bacteria grow in the control which do not grow to an equal extent in the inoculated cream. When cream is inoculated with one kind of bacteria in considerable quantity, other species of bacteria already present may be checked in their development by the growth of the inoculated species and prevented from producing their normal results. The control and the inoculated cream must have had at the end of pasteurization the same kind of bacteria present, but the inoculation of the cream with one species of bacteria in the artificial culture prevented those in the cream either from growing or from having their normal effect upon the cream.

This result is, indeed, not very surprising after all. Bacteriologists have for some time known that different species of bacteria may thus have a repressing influence upon each other. It has been determined, for instance, that the growth of the normal bacteria in milk prevents the growth there of the cholera bacillus, although the cholera bacillus will grow readily in milk that has been sterilized. Many other similar instances have been found, indicating that this is not an unusual but rather a common effect where different kinds of bacteria are

growing side by side. The importance of the matter to the butter-maker is considerable, inasmuch as it indicates that it may be possible, by inoculating cream quite heavily with one kind of bacteria, to check the influence of the other kinds which may be present. One can thus obtain the influence of the inoculated species but little modified by the growth of the other bacteria which are present in less abundance. During the last year or two butter-makers have become convinced of the advantage of using starters. They have found that in many cases the use of a starter, either a natural starter or one of the various pure cultures which are on the market, will improve their butter where it is added to ordinary cream. It has been something of a question how a starter can do any good in cream already more or less impregnated with bacteria. But if, as these experiments show, such a starter has the power of checking the growth of normal bacteria, we can understand the matter. If starters can have any influence checking the growth of bacteria already present we should expect that such starters would frequently improve butter, although not always. Thus, the facts here given offer an explanation of and emphasize the value of a starter of some kind in cream, both for the purpose of starting the proper kind of ripening, and also to check the development of many bacteria already present which might be injurious to the butter.

MOST BACTERIA HARMLESS OR BENEFICIAL.

Second.—The majority of the species tested may be regarded as indifferent in their effect upon the butter. About half of them when used to ripen the cream, as will be seen in the experiments described below, produced butter that had neither flavor nor aroma nor acid, and the butter was practically indistinguishable from the control butter. These species are the largest in number and present in the greatest variety around barns and dairies. They are perfectly wholesome in the cream. They do no injury, they do no special good, and we may, therefore, conclude from this that the majority of the species of bacteria that are present in the sources of our milk are wholesome forms, which may grow and develop in the cream without producing any trouble, and are perfectly consistent with the best quality of butter.

Third.—A considerable portion of the species found are positively favorable in their influence upon the butter. Of the sixty-eight species tested, twenty produced butter that has been described in our notes as good flavored. Of course the flavor was somewhat variable and its good character, while sometimes striking, was at other times moderate. It was not always the typical butter flavor and yet was such an approximation toward it that the butter would be regarded as of a good quality.

Fourth.—A smaller number of species produced injurious effects upon the butter; eighteen species among the sixty-eight tested have been described as producing butter that was bad, or poor, or strong flavored, or disagreeable; various adjectives being used to indicate the different effects. Some times the poor flavor was a putrefactive taste, in other cases it was a bitter taste; in others, again, a strong sour taste; while in still others the effect was of a peculiar indescribable character. In many of these eighteen species the pleasant flavor was very slight, and probably insufficient to materially injure the butter.

FLAVOR INDEPENDENT OF ACID.

Fifth.—Of the species of bacteria producing good flavors in the butter, many were of the acid-producing class. Of the twenty above mentioned, nine were lactic organisms. On the other hand, eleven were among the class which would be described as alkaline species, by which it is meant that they either produced an alkaline reaction in the milk or produced no change in its reaction. They are at all events distinctly not acid forms. Seven among them liquefy gelatine and are, therefore, among what are called the putrefactive bacteria. In thus speaking of the flavor, we have always tried to carefully distinguish flavor from acid taste. The flavors produced by the acid species (leaving out of account the sour taste resulting from the acid), and those produced by the other class were not particularly different. Independent of the acid it is doubtful whether there was enough difference in the flavors produced by the two classes of organisms to enable us to separate them from each other in this way.

Sixth.—Of the eighteen species described as producing injurious effects upon the flavor of the butter, nine belonged to

the acid-producing class, while nine belonged to the class developing alkaline reaction.

From these facts it appears to me a safe and perfectly legitimate inference that flavor is a matter entirely distinct from acid. It will be noticed that among the acid-producing species there are some that develop good flavor, while others develop a decidedly unpleasant flavor; and it will be noticed that among the species producing good flavors in the butter, while many of them are acid producers, a large number, eleven out of twenty, are among those that develop no acid. In speaking of the flavor as entirely distinct from the acid it is, of course, not meant to imply that they may not be associated. It may commonly happen, as will be noticed from these results, that the same species of bacteria may develop acid and flavor. This undoubtedly is the case with many of the bacteria of milk, and with most of the species of bacteria that are used by various butter-makers as cultures for artificial fermentation. Nevertheless, the fact that many of the species of bacteria produce acid and, at the same time, an unpleasant flavor and disagreeable effect upon the butter, while pleasant flavors are developed by species of bacteria which have not the acid-producing power, indicates clearly enough that the development of acid is not the same thing as the development of flavor. The development of the acid comes, as is well known, from the decomposition of the milk sugar, but the development of flavor comes, at all events, not from the same kind of decomposition of the milk sugar, and probably comes from some other kind of decomposition effect produced by these bacteria upon some of the ingredients of the cream. It is impossible at the present time to state, any more closely, to what the flavor is due, but the facts outlined above show clearly enough that the development of flavor and the development of the acid are not identical, and that while acid organisms may be the most promising ones for giving rise to the proper flavor in cream, these flavors may be due in many cases to organisms of an entirely different character. While, therefore, the lactic bacteria may be regarded as commonly producing the butter flavor in practical butter-making, they do not do this simply because they produce acid, and we must recognize that other types of bacteria probably assist in producing the desired flavor. It is important to note

in this connection that of the thirty species described as indifferent in their action, none were acid organisms

AROMA INDEPENDENT OF FLAVOR AND ACID.

Seventh.—Perhaps the most interesting result has to do with the production of the butter aroma. The butter aroma, the character that affects the nose rather than the palate, appears to be, at least so far as the results of the experiments are concerned, entirely independent of the flavor. Moreover, it appears to be a more unusual thing for bacteria to produce a desirable aroma than a desirable flavor. The great majority of these species tested give rise to practically none, or at least to an extremely slight aroma. Of sixty-five species whose effect on aroma is given below, thirty-nine produce no aroma at all. Of the species of bacteria which thus have no influence upon the aroma of butter, the majority, again, are among the class which either develop an alkaline reaction in the cream or do not change its reaction at all. Seven of those producing no aroma are among the class that produce lactic acid. Among those that do produce an aroma of a decided character, eighteen are described in my laboratory notes as producing an unpleasant or a bad aroma; seven of these are among those that produce lactic acid. The kind of aroma developed varied widely in these different species. Some times it was an extremely sour smell, at other times it was in a measure putrefactive. In most cases the aroma was of a character that was indescribable, from the lack of proper terms, but always unpleasant, and would always be regarded as characterizing a poor quality of butter. Among the sixty species studied, only eight have been found as yet to produce an aroma which has been described in my notes as good; and in only three has the aroma been that which is looked for in first-class butter. In two or three cases the aroma produced was of an extremely fine character, and in these artificial tests almost identical with the aroma expected in the first-class butter from a creamery. It has been interesting to find that, of the eight species which produce the aroma which has been described as good, none has been among the acid-producing organisms. The eight either develop an alkaline reaction or have no special effect upon the reaction of milk. There were three which developed the most typical aroma of all the species studied, Nos. 66, 69, and 104.

Two of these curdled milk by producing a rennet, both liquefying gelatine. The third did not curdle the milk. This result has been a surprise to me, inasmuch as I had supposed before the experiments began that the aroma was a matter very closely associated with the development of the lactic acid. These experiments are not sufficient to settle this question completely, especially since only eight species have been found to produce a desired aroma. It may be that in further experiments now going on lactic acid species also will be found associated with the development of aroma. It is, however, interesting to note that in the hands of European bacteriologists, so far as their experiments have gone, somewhat similar results have been obtained. There are, upon the European markets, several different kinds of pure cultures of bacteria used by creameries for ripening their cream. All of them are of the lactic acid type, and none of them is capable of developing aroma to any considerable extent. Recent work of Weigmann further confirms this result.* While he is inclined to think that aroma may be produced by lactic organisms, he regards the aroma as distinct from the acid quality, and the species of bacterium which he experimented upon as producing the best aroma was not of the acid-forming class.

This result cannot be surprising, and is, indeed, what might have been expected. Beyond question the aroma is due to volatile products, and these would most naturally be expected as resulting from albuminous decomposition. Lactic acid itself, as is well known, has no odor at all, and while sour milk has a peculiar odor, this odor, as was pointed out by Lister long ago, must be due to certain other products besides the lactic acid. The butter aroma, however, is not the odor of sour milk, but is one distinctly different. It is consequently an interesting and important point if we find that this butter aroma is associated with a different class of organisms from those which produce lactic acid. Herein we may probably find a partial explanation of the reason that the aroma of butter developed during the months of May, June, and July is of a higher character than that produced during other months of the year, since, at this period, the cream, as already noticed, is provided with a larger variety of bacteria, and, therefore, among them

* *Milchzeitung*, 1896, p. 793.

there is a greater chance of finding not only those producing acid, but also some which give rise to an aroma.

It has been found in these experiments thus far that none of the species tested combines all of the three characters—the power of producing flavor, acid, and aroma. Some develop flavor with the acid, others develop aroma with flavor, and others develop aroma without any special flavor. As yet no single species has been discovered that produces all simultaneously. This result is not, of course, surprising, for, recognizing that the ripening of cream must be an extremely complicated process, and produced by a large number of species of bacteria working together, it is a natural inference that the different qualities in the butter may be caused by different species of bacteria. It is by no means to be implied, however, that the three properties may not be combined in some species of bacteria.

Lastly, it is interesting to note that among the species of bacteria which produce good flavor in the butter, are found some that were quite widely distributed during the month of June. There was one species in particular, which, in my experiments, was described as giving rise to a good flavor and a strong acid, which was found during the months of May and June in each of the creameries from which samples of cream were taken. This, of course, is suggestive as indicating perhaps a reason for the common production of a good quality of butter during these months.

SUMMARY.

1. The cream in ordinary creameries or in ordinary dairies always contains bacteria, a large majority of which are perfectly wholesome, and which give rise either to good flavors and aromas in the butter or, at least, produce no injurious effect upon the cream. They are perfectly consistent with the production of the best quality of butter.

2. In the months of May and June the variety and the number of these types of bacteria is decidedly greater than in the winter months, and this probably explains, in part, the better quality of butter at these seasons.

3. Occasionally a dairy or a creamery may be impregnated with a species of bacteria that grows rapidly and produces a

deleterious effect upon its butter. This will produce in all cases a falling off in the quality. The trouble may be due, perhaps, to a single cow, inasmuch as the milk of individual cows may sometimes contain species of organisms not found in others, even in the same barn. It is, however, commonly impossible for the farmer or the butter-maker to find the source of such injurious bacteria.

4. Creameries and dairies will in many cases be supplied with bacteria giving rise to desirable flavors, aromas, and a proper amount of acid. This is commonly the case from the fact that the good-flavoring species are abundant, but it will not always be true. It is more common in June than at other seasons of the year, simply because the variety of bacteria is greater at this time, and hence the greater likelihood that some species which produce the proper aroma and flavor will be present. Probably, also, some of the desirable species are especially abundant in the green food of cows in June.

5. If cream be inoculated with a large culture of some particular kind of bacteria, this species will frequently develop so rapidly as to check the growth of the other bacteria present and thus, perhaps, prevent them from producing their natural effects. Hence, it will follow that the use of starters will commonly give rise to favorable results, even though the cream is already somewhat largely impregnated with other species of bacteria before the inoculation with the artificial starter. This fact lies at the basis of the use of artificial starters either with or without pasteurization. To produce the desirable result it is necessary to have the starter contain a large abundance of some favorable species which by its growth can both check the development of the ordinary cream bacteria and can develop a proper flavor by itself.

DETAILS OF EXPERIMENTS.

Before describing the experiments in detail a few words more may be in place as to the method of experimentation and recording results. The method by which different species have been tested as concerns their influence upon cream ripening and butter have already been described. It will be seen from the method thus given that the comparisons between the effects of the different organisms upon butter have been made under conditions in which they can be strictly accurate. When

from four to eight lots of butter are made from the same lot of cream, when one of these lots is a control experiment made from cream without inoculation, it is possible to make very accurate comparisons between the different samples as they are examined one after the other. Under these circumstances, where marked differences appear in the flavors or the aromas, there can be no question that they are due to the action of the organism in question. In spite, therefore, of the objection that the butter made in these cases was seldom made under conditions which would give rise to the best quality of product, it is thought that the comparisons that have been made between them are more strictly accurate and more valuable than could have been made in any other way.

In regard to the records, I have been very much at loss to find any satisfactory way of recording results. The flavors have been very varied, but our descriptive terms are so crude as yet as to make it impossible to describe these flavors in such a way as to enable another person to recognize them. Few of the flavors which have been recognized are such as are commonly found in butter, and yet many of them have been so pleasant and so akin to butter flavors that I have been convinced that the butter flavor of ordinary butter may be made up of the combination of a number of the different flavors produced by the different species of bacteria. Still greater is this difficulty in regard to the records upon the aroma of the butter. There is practically no way of describing the aroma so that it can be distinguished by another person unless it chances to have a distinct similarity to some well-known odor. I have, therefore, been obliged in these experiments simply to speak of the flavors and aromas as pleasant or unpleasant, as typical or not of the typical character, and as, therefore, contributing in my own judgment to the good or the bad qualities of butter. I recognize also that different individuals would describe these results in a different way. In most cases Mr. Esten as well as myself made an examination of the butter, but our *descriptions* of the flavors and aromas seldom agreed, although we did agree in all cases as to whether a given aroma and flavor was pleasant, and, therefore, favorable to butter-making, or unpleasant, and, therefore, unfavorable to butter-making. In spite of this unsatisfactory condition of the records upon the action of

the organisms upon butter, it is thought that the general result, namely, the relations of the organisms to the production of normal, first-class butter, is reliable and is valuable.

The species of bacteria which have been used in the following experiments have been obtained at various times in the last two years from a variety of sources. All of them have come from dairy products, many of them directly from cream in creameries. Some have been derived from milk, some from the milk as it is drawn from the cow, others from the dust that has fallen from the cow during the milking, collected directly in gelatine plates. They may all, therefore, be regarded as distinctly dairy bacteria. These organisms have been carefully studied, and their characters determined in the laboratory before the butter experiments have been undertaken. It has been thought best, however, not to give here the detailed descriptions of these species. My list of Connecticut dairy bacteria is increasing, and each month is giving more information in regard to the relation of these bacteria to each other from a systematic standpoint. It is thought, therefore, that if the description of these species be reserved till a later date more valuable inferences can be made as to the distinctness of the types described and their relations to each other; and the results will, therefore, be a more valuable contribution to the vexed question of the limits of species among bacteria. These descriptions will, therefore, be reserved for later publications.

In the description of the butter-making experiments each organism is referred to by a number, which refers to the number in my own private list. There will be given in each case the source from which the organism was derived and its effect upon milk, inasmuch as these are factors directly concerned in the practical experiments to be described. Note will also be made of the power to liquefy gelatine, since this will in a measure distinguish the organisms which act on the albumens. The temperatures are all centigrade:

Species No. 21.

This is a slender bacillus which is extremely common in the dairies of Connecticut. It liquefies gelatine and produces a fluorescent green color, and is one of the most common of our organisms. It has the effect of curdling milk in about three days, rendering it very slightly alkaline. Some varieties of the species appear to digest milk without first curdling it. Its effect upon cream is

to thicken it, with a rather strong odor. The butter made therefrom is moderately good in flavor, but the flavor is so slight that the butter would not be regarded as good. There is no special effect upon the aroma unless over-ripened.

Species No. 31.

A slender bacillus which very slowly liquefies gelatine, turning it green. It is also a very common species in the dairies of Connecticut, having been found in many places. It curdles milk into a soft, slimy curd at 20° in about two days. A digestion of the curd begins at once and the milk finally becomes a yellowish green liquid with an alkaline reaction. Cream is slightly thickened by it, and the butter made therefrom, if the cream is not much ripened, is very flat and tasteless, with no special aroma. If the ripening continues further the butter is strong, tallowy and unpleasant. This organism, therefore, is unfavorable in its effect upon butter, producing undesirable flavors and aromas.

Species No. 63.

A short bacillus found at Elmwood, Conn. It renders the milk acid, curdling it after several days. Cream is filled with gas bubbles, is acid, and the butter made therefrom has a good, rich flavor, being decidedly good in character. Unfortunately, no note was taken at the time of the experiment of the aroma produced.

Species No. 64.

A bacillus found at Cromwell and also at Durham. It liquefies gelatine and digests milk into amphoteric or weak alkaline liquid, but with no proper curdling, and with rather an unpleasant odor. Butter made from the ripened cream possesses a good flavor and an aroma which is pleasant. The cream has a slight putrefactive odor, but the butter made therefrom does not show the effect of this odor unless highly ripened.

Species No. 65.

A micrococcus form found at Durham, Wapping, Elmwood, Cromwell and Storrs. It does not liquefy gelatine. It curdles milk in about two weeks, rendering it acid. Cream becomes pleasantly sour, slightly acid to litmus, and the butter made therefrom has an excellent, first-class, rich flavor. The aroma of the butter, however, is slight—at all events, not that of butter.

Species No. 66.

A bacillus found at Cromwell and at Storrs. It does not liquefy gelatine. Milk is not affected by it, except that it becomes slightly transparent and alkaline. Butter made from cream ripened with the organism develops an excellent flavor, which is described as "nutty," and has a good aroma. The butter has been described as first class, both in flavor and aroma.

Species No. 68.

A bacillus found at Cromwell. It liquefies gelatine and digests milk, sometimes without previous curdling and sometimes with a previous curdling. The digested milk is strongly alkaline. The cream inoculated with it develops a slight flavor, but the butter made therefrom is practically tasteless and has no aroma.

Species No. 69.

A bacterium found in Middletown. It liquefies gelatine, curdles milk in three to six days, and then digests the curd into a colorless alkaline liquid with a bitter taste. Cream is slightly thickened thereby, and the butter made from the cream has a sharp, almost bitter, sour taste, which is not specially pleasant, but the aroma is exceptionally fine, appearing to be identical with the aroma of the highest grade of butter. This fine aroma was developed in every case in which the experiment was made, and could hardly be distinguished from that of first-class market butter. The butter, however, was not first class, because the flavor was too sharp.

Species No. 70.

A micrococcus found at Durham. It does not liquefy gelatine, and has little effect upon milk. Butter made therefrom has a slight but good flavor; no noticeable aroma.

Species No. 71.

A bacillus found at Cromwell. It does not liquefy gelatine. Milk is curdled after three days at 36° and is slightly acid. Butter made from cream inoculated with it has a slightly sour taste, but a good flavor and no special aroma.

Species No. 72.

A bacterium found at Cromwell. Does not liquefy gelatine. It curdles milk at 36° in two days with an acid reaction. Butter made from cream inoculated with it has a very sour and decidedly unpleasant taste. When ripened sufficiently to develop flavor and aroma both are decidedly disagreeable, and the butter is very poor.

Species No. 73.

A bacillus found at Cromwell. It does not liquefy gelatine, and upon milk it appears to have no effect. Butter made from cream inoculated with it has a very slight flavor and aroma, not unpleasant, but so slight as to make the butter rather flat and tasteless.

Species No. 74.

A bacillus found at Durham, and also at Elmwood. It does not liquefy gelatine, and appears to have no effect upon milk, except to render it slightly slimy after about three weeks. Butter made from cream ripened by means of it has neither flavor nor aroma unless the ripening is continued too long, and then there develops a slight flavor of decay.

Species No. 75.

A micrococcus found at Durham. It does not liquefy gelatine. It has no effect upon milk, and produces butter which has neither appreciable flavor nor aroma.

Species No. 76.

A bacillus found at Durham. It does not liquefy gelatine, has no effect upon milk, and is absolutely without any influence upon either the flavor or the aroma of butter.

Species No. 77.

A bacillus found at Cromwell. It does not liquefy gelatine, and has no effect upon milk, except to render it slightly slimy. Butter made from cream inoculated with it develops a moderately good flavor and a good aroma, not very strong, but decidedly better in flavor and aroma than the control.

Species No. 78.

A micrococcus found at Ellington and at Storrs. It does not liquefy gelatine. It renders milk acid at 20° without curdling it. The acid is sufficient, however, to curdle the milk when it is boiled. At 35° the milk is curdled. Butter made from the cream develops a decidedly pleasant flavor, unless the ripening is too long, when the flavor is rather sharp and bitter. There is, however, no noticeable aroma. The organism develops flavor without aroma.

Species No. 79.

A bacterium found at Ellington. It does not liquefy gelatine. It renders milk acid, and sometimes curdles the milk after two weeks at a temperature of 20°, at other times not curdling the milk although rendering it acid. At 38° a curd is developed. The butter made from it is decidedly sour and unpleasant in flavor with no appreciable aroma.

Species No. 80.

A micrococcus found at Ellington. It does not liquefy gelatine, has no effect upon milk, and no effect upon either the flavor or the aroma of butter.

Species No. 82.

A bacillus found at Ellington. It does not liquefy gelatine, and has no effect upon milk at any temperature, and no effect upon either the flavor or the aroma of butter.

Species No. 83.

A bacillus found at Cromwell. It liquefies gelatine and curdles milk, rendering it slimy. The reaction is alkaline. The butter has a clean, sharp taste, with a yeasty aroma.

Species No. 84.

A bacillus found at Ellington. It does not liquefy gelatine, and has no effect upon milk except to render it slightly alkaline. It has no effect upon either the flavor or aroma of butter, the butter being tasteless.

Species No. 85.

A micrococcus found at Cromwell and at Storrs. It does not liquefy gelatine. It has no effect upon the milk, except to render it slightly alkaline and slightly slimy. It produces neither flavor nor aroma, the butter being tasteless.

Species No. 86.

A bacillus found at Cromwell. It does not liquefy gelatine. It does not curdle milk, but slowly digests it into a watery liquid which is alkaline. At 35° it is curdled and subsequently digested. Butter made from cream inoculated with it develops a strong taste of decay and a strong, unpleasant aroma. The butter is decidely unpleasant.

Species No. 87.

A bacillus found in Middletown. It does not liquefy gelatine nor curdle milk at 20°, though it renders it sufficiently acid to curdle when heated. At 35° the milk is curdled and rendered acid. Butter made from cream ripened with it is not pleasant. Neither the flavor nor the aroma is that of butter, but is somewhat similar to that of cooked milk.

Species No. 88.

A bacterium found at Canton. It liquefies gelatine and curdles the milk in six days, rendering it alkaline, and subsequently digests the curd. When allowed to ripen cream for a moderate length of time it produces no effect whatsoever upon the butter, neither taste nor aroma being noticeable.

Species No. 89.

A bacillus found at Cromwell. It does not liquefy gelatine but curdles milk in six days, rendering it acid. Cream is also thickened and soured, and butter made therefrom has too sour a taste to be pleasant. No record was made of the aroma.

Species No. 90.

A bacillus found at Elmwood. It does not liquefy gelatine and has no effect upon the milk except to produce slight alkalinity. Butter made from cream develops a decidedly pleasant flavor, though slight. There is also developed a slight pleasant aroma.

Species No. 91.

A bacillus found at Canton. It does not liquefy gelatine. It curdles milk in six to nine days into a hard acid curd with a decidedly sour odor. When allowed to ripen cream it develops a good flavor in the butter, though not very strong. No aroma whatsoever appears to be produced.

Species No. 92.

A bacillus found at Elmwood. It liquefies gelatine. At 20° it digests milk without curdling it, producing an alkaline solution. At 36° it first curdles the milk and subsequently digests the curd. Cream ripened with it produces butter without flavor or aroma. A strictly neutral species.

Species No. 93.

A bacterium found in Middletown. It does not liquefy gelatine nor curdle milk at 20°, though it renders it sufficiently acid to curdle when boiled. At 36° it curdles milk. Butter made from cream ripened by it has a sour and distinctly cheesy taste which is unpleasant. There is no butter aroma, though the cheesy aroma is noticeable.

Species No. 94.

A bacterium found at Elmwood and at Storrs. It does not liquefy gelatine but curdles milk in eleven to twelve days at 20° into a hard curd which is acid. Butter made from cream ripened by it is too sour to be good. A sour aroma also commonly developed. If the ripening be slight the flavor is not unpleasant, but the sour taste and aroma develop very quickly.

Species No. 95.

A bacterium found at Wapping. It does not liquefy gelatine and has no effect upon milk. It has little effect upon the butter, producing a very slight flavor, which is pleasant, but no aroma.

Species No. 96.

A bacillus found at Cromwell, and also at Middletown. It liquefies gelatine. Occasionally it curdles milk, rendering it slightly alkaline. It produces no effect upon the butter, either as to aroma or flavor.

Species No. 97.

A bacterium found at Ellington. It does not liquefy gelatine and has no effect upon milk. Butter is not affected by it, having neither flavor nor aroma.

Species No. 98.

A bacillus found at Cromwell. It does not liquefy gelatine and has no effect upon milk except to render it slightly alkaline and transparent. Butter made from cream ripened by it has very little flavor, but it has a peculiar, though rather unusual aroma, which is unpleasant, and not a typical butter aroma.

Species No. 100.

A bacterium found at Canton. It does not liquefy gelatine and has no effect upon milk. Cream ripened by it gives butter a pronounced flavor which is rather unpleasant when strong, and is not a normal butter flavor. Slight aroma is developed, which is much like that of good butter.

Species No. 101.

A bacillus found at Middletown, Cromwell and Storrs. It liquefies gelatine and curdles milk into a soft curd, with no change in reaction. The curd is slightly digested and develops a cheesy odor. Cream ripened by it produces butter with a moderately good but slightly cheesy flavor, and it has a cheesy aroma. The variety found at Storrs appears to be identical with the others, except that is does not develop a cheesy aroma.

Species No. 102.

A large bacillus found at Middletown. It liquefies gelatine and curdles milk into a soft, faintly alkaline curd, which subsequently digests with a rancid odor. When allowed to ripen cream for a normal length of time, however, it produces no flavor or aroma in the butter.

Species No. 103.

A very common bacterium found both in Middletown and Storrs. It liquefies gelatine but does not curdle milk. It renders milk slightly alkaline and of a slightly dark color. Butter made by means of it develops a slight flavor which is not very good, but not unpleasant. An unpleasant aroma of decay is developed, however, so that the butter is unpleasant.

Species No. 104.

A large micrococcus found in Middletown. It very slowly liquefies gelatine, and curdles milk in eleven days, with no change in reaction. This organism

appears to be extremely variable. It is, however, very common, being, indeed, one of the most common species found in the dairies studied. It has been found in several of the localities mentioned, but appears to vary in its effect upon milk and butter. It usually curdles milk, though occasionally not. Butter made from it sometimes develops a perfectly typical butter aroma, without any flavor,—as fine as that produced by any of the species studied. In other varieties, however, the aroma does not appear to be developed. From the many experiments made I have concluded that it is a widely variable species, varying not only in its general characters, but also in the type of decomposition it produces. The effect of the different varieties upon butter can never be relied upon.

Species No. 105.

A bacillus found at Canton. It does not liquefy gelatine and has no effect upon milk. Butter made from cream inoculated with it develops a slight flavor, which has not an especially pleasant taste, but is not disagreeable. The aroma is noticeable, but very slight, and is not a typical butter aroma. The butter is, in other words, moderately good, but not a first-class product.

Species No. 106.

A bacterium found in Middletown. It does not liquefy gelatine, and has no effect upon milk at any temperature. It produces no flavor and no aroma in the butter.

Species No. 107.

A bacillus found in Middletown. It does not liquefy gelatine or curdle milk at 36°. It renders milk, however, slightly acid, so that it curdles when heated. Butter made from cream ripened by it has a sour clean taste, but with little flavor besides the sour taste. It has a strong aroma, also, which is best developed after about forty-eight hours of ripening. The aroma is strong, but not that of typical butter.

Species No. 108.

A bacterium found in Middletown. It does not liquefy gelatine or curdle milk, though it renders it slightly acid. At 35° it may, in some instances, curdle the milk. Butter made from cream ripened by it is slightly sour, but has a pleasant flavor. It has also an aroma which is decidedly sour, strong, and not typical; it is, indeed, rather yeasty. The flavor is thus good while the aroma is unpleasant.

Species No. 109.

A large micrococcus found in Middletown. It liquefies gelatine, curdles milk with subsequent digestion at 35°, and at 20° digests without curdling. The digested solution is strongly alkaline. Butter made from cream ripened by it is very little affected. There is very slight flavor and aroma, but the butter is quite flat and insipid.

Species No. 110.

A micrococcus found in Middletown. It liquefies gelatine, curdles milk in one day at 36°, and in two days at 20°. It subsequently digests the curd, the resulting liquid being decidedly alkaline. Butter made from cream ripened by it, however, develops no appreciable flavor or aroma, though sometimes there is a slightly bitter taste. The organism is usually neutral in its effect on butter.

Species No. 111.

A bacillus found at Storrs and also in Middletown. It is an extremely common organism. It liquefies gelatine, curdles milk rapidly at both 36° and at 20°, and digests into a watery alkaline solution. Butter made from cream ripened by it is bitter and unpleasant. It has, however, a decided aroma, though not a typical butter aroma.

Species No. 112.

A bacterium found at Storrs. It does not liquefy gelatine or curdle milk either at 20° or at 35°. The milk, however, is rendered acid, and curdles when heated. Butter made from it has a strong, unpleasant aroma, and a sour, unpleasant taste. What appeared to be the same species was found later in the same dairy, but its effect was not so bad, though it did not produce good butter.

Species No. 113.

A micrococcus found at Storrs and at Middletown. It appears to be the most common dairy bacterium found in these localities. It is very variable, ranging in its powers of producing pigment from a snow white to a deep orange. There are all intermediate grades, so that the extreme types are probably of the same species. It liquefies gelatine; curdles milk both at 36° and 20° into a soft curd which is amphoteric. It produces subsequently little or no digestion of the curd. In its effect upon butter it appears to be a favorable species, inasmuch as the flavor that is produced is pleasant, though very slight. It produces, apparently, no aroma. It cannot, therefore, be regarded as especially valuable in butter-making, but its influence is advantageous, so far as it has any at all.

Species No. 114.

A bacillus found at Storrs. It liquefies gelatine and curdles milk after six days. The curd is alkaline and is slowly digested. At 20° it digests without curdling into an alkaline solution. It appears to have absolutely no effect upon butter either in developing flavor or aroma.

Species No. 115.

A bacterium found at Storrs. It liquefies gelatine; curdles milk into a soft curd, which subsequently digests into an alkaline liquid. At 20° there is no curdling, but a digestion occurs without curdling. Its effect upon butter is ordinarily very slight. When cream is ripened for two days at a rather high temperature there is produced, however, a decidedly fine flavor of butter with a good aroma, though neither flavor nor aroma are quite that of typical first-class butter.

Species No. 116.

A large micrococcus found at Storrs. It liquefies gelatine very slowly. It does not curdle milk, but very slowly digests it into a watery liquid which is slightly alkaline. This effect is only produced after about four weeks. When used to ripen cream for a normal length of time it has no effect upon it whatsoever, producing neither flavor nor aroma in the butter.

Species No. 117.

A large micrococcus found at Storrs. It liquefies gelatine slowly. It renders milk quite strongly alkaline, but produces no other change. When used for ripening cream it produces butter with no aroma, and, practically, no flavor. If the cream is over-ripened a flavor and aroma of decay is noticeable.

Species No. 119.

A Sarcina form found at Storrs. It liquefies gelatine and curdles milk in three days at 20° with no change in reaction. Butter made from cream ripened by it is usually without flavor or aroma, but if the ripening be prolonged a flavor is produced, and a pleasant, though not typical, aroma.

Species No. 123.

A bacterium found at Storrs. It liquefies gelatine. It curdles milk rapidly at 36° into a hard alkaline curd which is rapidly digested. Butter made from cream ripened by it develops, when slightly ripened, no flavor and a slight, but unpleasant aroma. If the ripening is continued too long there is developed a flavor and aroma of decay.

Species No. 125.

A bacillus found at Storrs, where it is quite common. It does not liquefy gelatine. It curdles milk after two weeks with an acid reaction. The acid appears first at the bottom, and later spreads throughout. Butter produced by means of it develops a sour, clean taste, pleasant, but rather too sour for good butter. It has, however, no appreciable aroma.

Species No. 126.

A bacillus found at Storrs. It does not liquefy gelatine. It has no effect upon milk, except to develop a slight cheesy aroma. Butter made therefrom develops a strong cheesy aroma and a flavor which is also cheesy, and with a slightly decayed taint which is very noticeable and uniform.

Species No. 129.

A bacterium found at Storrs. It liquefies gelatine slowly. It curdles milk with an alkaline reaction. There is subsequently a slight digestion of the curd, and the liquid is slimy. Butter made from cream ripened by means of it has neither flavor nor aroma; or when more ripened, there is an aroma developed of an unusual character,— not that of butter.

Species No. 130.

A micrococcus found at Storrs. It does not liquefy gelatine. It renders milk acid, but does not curdle it. The milk, however, is in a short time rendered extremly slimy, and capable of being drawn out into long slimy threads. Cream inoculated by it also becomes slimy in an ordinary ripening, but there is no apparent effect upon the flavor or aroma of the butter, the butter appearing to be without either taste or smell.

Species No. 131.

A large bacterium found at Storrs. It liquefies gelatine and curdles milk in two days, with little change in reaction. Very slight digestion is to be seen.

Butter develops a rather sharp, sour (?) taste, which is pleasant and like that of good butter. No aroma is noticed. The butter has thus a good flavor, but without aroma.

Species No. 132.

A micrococcus found at Middletown and at Storrs. It does not liquefy gelatine and has no effect upon milk, except to render it slightly alkaline. Butter made from cream ripened by it has no appreciable flavor or aroma.

Species No. 134.

A bacterium found at Storrs. It does not liquefy gelatine. It renders milk sufficiently acid to curdle when heated, but does not curdle unless heated. Cream inoculated by it has a sharp, penetrating, musty odor and taste, and the butter made therefrom has the same sharp, penetrating taste and aroma. It is not unpleasant, but not typical, and the butter is not first-class.

Species No. 136.

A bacillus found at Storrs, which, while much like No. 97, differs from it in its effect on butter. When cream is ripened by it for two days, there is developed a decidedly good flavor, which is, however, not quite like that of good butter. If less ripened, no flavor develops. There is no aroma.

Species No. 137.

A bacillus found at Storrs. It does not liquefy gelatine. Sometimes it curdles and sometimes it does not curdle milk. There is no change in the reaction of the milk and no digestion. Butter made from cream ripened by it is without either flavor or aroma.

Species No. 138.

A large bacillus found at Middletown. It liquefies gelatine. It curdles milk at 20°, producing a soft curd, which begins to digest almost at once into a colorless, cloudy liquid, which is alkaline. Butter made from cream much ripened by it has a decayed taste and aroma, and if only slightly ripened no appreciable taste or aroma is noticed.

Species No. 139.

A bacillus found in Middletown. It liquefies gelatine and curdles milk in six days without changing the reaction, or occasionally rendering it slightly acid. It develops later a prominent cheesy odor. Cream inoculated with it develops a cheesy odor and taste, and butter made therefrom has the same strong cheesy taste and flavor.

Species No. 143.

A micrococcus found in Middletown. It does not liquefy gelatine, and curdles milk at 20° in from six to nine days. There is no change in the reaction. Butter made from cream ripened by it has no flavor and no aroma, or, at most, a very slight aroma. If the ripening continues too long an aroma and flavor of decay make their appearance.

BACTERIA IN THE DAIRY.

XII.—BACILLUS ACIDI LACTICI AND OTHER ACID ORGANISMS FOUND IN AMERICAN DAIRIES.*

BY W. M. ESTEN, M. S.

I.—BRIEF HISTORY OF EARLY WORK.

In the year 1877 Lister, by means of a capillary pipette to which was attached a screw-head so adjusted that he could force out one-hundredth of a drop of a diluted solution of milk, obtained the first pure culture of a milk-souring organism, which he called *Bacterium lactis*. Lister thus has the honor of being the first to discover and isolate as a pure culture the organism which was subsequently more carefully studied by Hueppe, and named *Bacillus acidi lactici*.

By means of modern bacteriological methods Hueppe was able to make a very thorough investigation of the physiological functions and morphology of this organism, which has been of much value as a standard for the work since done, even up to the present time. Although the characteristics of the organism noted by him do not coincide in every detail with those of the organism recently studied by Günther and Thierfelder and myself, they are all near enough in the essential points to be classed together.

In 1886, Beyer, of Washington, D. C., studied lactic acid fermentations in milk, repeating some of the experiments of Hueppe. The work was incomplete, for he reported studying but one sample of milk, and left out some of the more important features of the analysis for determining the characteristics of this organism. The morphology as described by him is identical with the one recently studied here. The work is not, however, sufficient in detail to determine definitely whether or not he obtained Hueppe's bacillus, though its power to curdle milk in a few hours was rather convincing evidence that he did.

* The account herewith is taken from a more extended report which has been prepared by the author.

After Hueppe, Marpmann, Grotenfelt, and Keyser have isolated milk-souring organisms which agree very well with Hueppe's bacillus. Many other investigators have isolated quite a number of organisms which sour milk, but which are not like *Bacillus acidi lactici*.

Investigators, both in Europe and the United States, having sought to discover Hueppe's bacillus, and frequently failing to do so, though obtaining other milk-souring organisms, have concluded that there are a number of different kinds of organisms which have the power of producing lactic acid from milk sugar and thus precipitating the casein of the milk. This, doubtless, is true, but it does not preclude the fact that there may be one organism which is so universally found in dairies, and is so commonly the cause of milk souring, as to deserve to be regarded as the lactic organism of milk *par excellence*.

The question whether there is one or many organisms which commonly sour milk was discussed pro and con until 1894, nothing definite being determined.

At this time Drs. Günther and Thierfelder published the results of their work.* The character of their work was of the highest order. Their specimens of milk came from a large number of milkmen around the City of Berlin, giving a check to those specimens which might be abnormal, and which if, by chance they were the only ones studied, might give an erroneous conclusion. The method used in the gelatine plate cultures was to put into the prepared gelatine a definite amount of calcium carbonate. This made a somewhat dense medium, but, since the carbonate is very soluble in acids, wherever an acid colony developed it would become surrounded by a clear spot. From a large number of experiments, and the constancy of results, they concluded that there was one organism identical with Lister's *Bacterium lactis* and Hueppe's *Bacillus acidi lactici*, which caused the true ordinary souring of milk.

II.—GENERAL STATUS AND OUTLINE OF FACTS.

In the United States there had been no analytical work on the acid organisms of milk as a distinct work by itself, until October, 1894, when a series of experiments were commenced

* "Bacteriologische und Chemische Untersuchungen über die spontane Milchgerinnung." Aus dem Hygienischen Institut der Universität, Berlin. Archiv für Hygiene.

in the Biological Laboratory of Wesleyan University, to determine whether a miscellaneous collection of species of bacteria caused the common acid fermentation of milk or whether there is a special one which is ubiquitous and like the one found in Europe.

Several organisms were isolated from milk and studied. It was a prominent fact that the majority of organisms were anaerobes or facultative anaerobes. These were discarded as many others have done in studying milk organisms because they do not grow on the surface of culture media, or if they do, grow very scantily. The territory studied was in the city of Middletown and a section of Northern Rhode Island. Some species were found to be identical in both localities, but nothing definite was determined. Some species curdled milk; others made it acid, without curdling. There was this striking fact that there was no one organism in either place which seemed to produce a typical sour milk.

In the early part of the present year (1896) a second series of experiments were conducted, in which it was considered advisable to make a study of milk in a much wider territory. In these experiments the facultative anaerobes were picked out and studied. Some of these were found to be very strongly acid when grown in blue-litmus gelatine, which was especially prepared for the study of the acid organisms.

The widest extent of territory from which samples of milk have been received is from Ohio to Massachusetts and from Maine to Pennsylvania.

Through the kindness of students I have been enabled to receive these samples of milk from many localities and a wide extent of territory. The definite localities are Elyria, Ohio; Buffalo, Western; Wellsboro, Northern; and two places on Long Island, Southern New York; Mahanoy City, Pennsylvania; Turner's Falls, Northern; and Uxbridge, Southern Massachusetts; Mt. Desert Island and North Wayne, Maine; Plymouth, New Hampshire; Eastford, Norwich, Higganum and Middletown, Connecticut; Glendale and Oakland, Rhode Island. Single samples have been received from Wellsboro and Long Island, New York; Mahanoy City, Pennsylvania; Turner's Falls, Massachusetts; North Wayne, Maine; Plymouth, New Hampshire; Norwich, Higganum and Eastford, Connecticut. From the other localities from two to five

specimens have been received from the same place. The Rhode Island locality was very carefully studied. Milk was collected from twelve dairies in this section, in as fresh a condition as possible. In four samples it was taken direct from the teat. From most of the dairies many samples have been received, some of mixed milk, others from one cow.

Thirty dairies have furnished fifty-three samples of milk, from which one hundred and eleven colonies have been isolated. Thirty-four of these were discarded as not producing acid, or as nearly anaerobic. Of the seventy-seven studied, forty-seven of them appeared to be the same species. Although the analysis of these forty-seven severally is not identical in some of the minor details, yet in the most important distinctions they agree. The distinctive character of this species is the power of curdling milk in a very short space of time. The actual limit has not been determined; but sterile milk inoculated with a small amount of culture, placed at thirty-five degrees centigrade, was examined in twelve hours and found to be thoroughly curdled. At the normal room temperature it curdles milk in from sixteen to thirty-six hours.

Along with this species, and supposed to be the same when first picked out, were ten others, which in all the culture tests seemed to be identical in character with the forty-seven, with the exception that they did not curdle milk, although they did make it acid. Some rendered milk strongly acid, others weakly acid. These facts seem to suggest that they are the same species as the forty-seven, but that these ten had lost the power of curdling milk.

Of the twenty remaining organisms ten were aerobes and produced acid sufficient to curdle milk. Three of these were the same species, one coming from Ohio, and the other two from Massachusetts. These aerobic acid organisms were taken from six samples. The forty-seven facultative anaerobic acid curdling specimens, which were alike, were found in the fifty-three samples of milk studied.

III.—TECHNIQUE OF EXPERIMENTS AND ANALYSIS OF THE PRINCIPAL ORGANISM.

Ordinary peptone-gelatine was prepared, to which was added 3 per cent. of milk sugar and dry blue litmus, in the proportion of one to thirty parts of the culture medium. The gelatine

solution was neutralized so that it was slightly acid to phenolthphaline. Into this blue gelatine a small amount of diluted souring milk was inoculated, in the usual manner. After three or four days small red spots appeared where the acid bacteria developed. This simplifies the work very much, since the acid and alkaline organisms are differentiated at once. All of the culture media were prepared with three per cent. of milk sugar.

Fresh milk was allowed to stand until it commenced to curdle. At this stage there would be more of the typical acid organisms than at any previous or subsequent time in the changes of the milk. The dilutions were made with a platinum loop full of milk in five centimeters of sterile water. Those plates in which liquefiers were present prevented the discovery of the slow-growing acid organisms. When but a few or no liquefiers were present, in three or four days there would appear below the surface bright red spots, which showed very clearly in the surrounding blue. Not many acid colonies grew on the surface of the gelatine. The most abundant on the surface were moulds, yeasts, neutral and alkaline bacteria. The first sample of milk from one dairy had nearly a pure culture of an alkaline liquefier, although the milk was acid in reaction. The next sample from the same place, collected two weeks later, had not a single liquefier, but a nearly pure culture of one organism, which appears to be the one so commonly present in nearly all the samples, and agrees so closely with the one isolated by Günther and Thierfelder that it is called *Bacillus acidi lactici* of Hueppe.

PHYSIOLOGICAL AND MORPHOLOGICAL CHARACTERS OF BACILLUS ACIDI LACTICI AS FOUND IN MILK IN THE UNITED STATES.

I.—BLUE LITMUS GELATINE.

It requires from two to three days to develop a typical colony. Under a low power of the microscope, one inch objective, a small colony appears, surrounded by an intense red halo. The colony appears to be covered with short stumpy spines, which give it the appearance of a chestnut burr, and from which it has been named the *burr colony*. Under a high power these spines are found to be granular processes which extend

for a short distance into the surrounding medium. In some instances there will be a dark centre surrounded by a lighter rim. Their size is always less than one millimeter. The more common appearance under the microscope is a dark-colored, spiny, slightly yellowish colony, homogenous in density. They never appear to grow on the surface, but, in some cases, very near the surface, with a thin layer of gelatine above it raised by the growth of the colony.

II.—ORDINARY GELATINE.

There is produced in this medium a small circular colony which is finely granular; pearly white by reflected light, and slightly yellowish by transmitted light. The growth is very slow.

MORPHOLOGY.

In bouillon there appear short plump rods, many of them in figure 8's, some in chains of three to six in number. To make these, a rod, after lengthening, partially breaks up into five or six. The common method of multiplication is, for a rod to lengthen and divide in the middle, the connection between the two remaining for some time. Average size is 1.2μ long by $.7\mu$ wide.*

MOTILITY.

They are never motile.

TEMPERATURE.

The growth is very rapid in milk at temperatures from 28° to 37½° C. On agar-agar they do not grow so rapidly at a high temperature, and even, in some instances, do not grow on the surface of agar-agar at 37½° C.

RELATION TO AIR.

They grow more vigorously out of contact with the air, under mica plates producing more acid than in free gelatine.

GELATINE STAB CULTURES.

Growth entirely below surface along the needle track, which is abundant, beady, rough, and densely white.

AGAR-AGAR TUBES.

It grows on the surface of agar-agar very scantily, not more than one or two mm. wide, in a very thin layer. If held to the

* μ equals $\frac{1}{25,000}$ of an inch.

light, at the proper angle, spectral colors will be observed. The stab growth in agar-agar is more abundant, and affords the only method of keeping it alive, because it soon dries up the surface and dies.

CULTURE ON POTATO.

Grows on potato very sparingly, in a thin, pearly, white layer, sometimes scarcely visible.

BOUILLON.

In milk-sugar bouillon the liquid becomes densely turbid. In a week it gradually settles, giving a light gray sediment in a clear liquid. No scum or gas production is observed. Sometimes a light-colored ring is formed on the glass at top of liquid.

STERILIZED MILK.

Cultures inoculated into sterile milk at 20° C. curdle it in twenty-four hours. At 35° C. it curdles milk in less than twelve hours. The curd is homogenous and of jelly consistency, so that the tube can be inverted without displacing the contents. The milk shrinks in curdling, leaving a concave surface on the top of the milk. After the curdling the milk undergoes no further visible change. A few drops of clear whey separates on top of the milk. The curd and clear liquid are intensely acid. No evidence of gas production or odor present.

GENERAL REMARKS.

It does not appear to produce spores. Hueppe describes it as a spore-forming species, but this appears to be an error. In staining specimens of these organisms the centers quite frequently remain unstained, which might lead to the misconception that spores are present. The unstained portion does not show a glistening appearance, which is an optical effect produced by spores.

The organism is quite difficult to cultivate. It lives but a short time on the surface of agar-agar, grows entirely below surface of gelatine, and very slowly in culture media at ordinary room temperatures. Its home seems to be milk, where it flourishes to the best advantage at a temperature nearly that of the heat of the body.

The habitat of this organism is a problem which is interesting for further investigation. A few experiments were tried to determine whether it came from hay dust or some other

source. Hay and hay dust were collected from three barns and put into sterile milk and left to undergo fermentation. The changes were very tardy in making their appearance. In a few days the milk curdled and gelatine plate cultures were made from the milk tubes. There were several kinds of alkaline and acid organisms, but none that resembled *Bacillus acidi lactici*. There was present a very vigorously growing, strongly acid-producing organism.

Four experiments were tried with milk direct from the cow's teat. The first experiment from a cow in Rhode Island was very remarkable. The milk collected was the first drawn, in which it is supposed that the germs are most abundant. The milk remained in a warm room for twenty-two days before it curdled, and the organisms then obtained from it were not acid.

The second experiment from the same cow gave a nearly pure culture of *Bacillus acidi lactici*. Two experiments were tried in the same manner with the milk of a single cow in Massachusetts, both of which gave a majority of *Bacillus acidi lactici* colonies. From these insufficient data is suggested the possibility that *Bacillus acidi lactici* comes from the cow in the milk duct, since its maximum temperature of growth is about that of the body temperature.

There were three species of organisms so closely allied to *Bacillus acidi lactici* that I consider them varieties of that organism. The first was found at Sagaponack and Miller's Place, New York, and Glendale, Rhode Island. The points in which it differs from *Bacillus acidi lactici* are, that it does not grow at 35° C., and though it renders milk strongly acid it does not curdle it. The second, found at Glendale, Rhode Island, was almost identical with the first, except that it rendered milk only slightly acid. The third, found at Uxbridge, Massachusetts, was like the second, but grew at 37½° C.

Many of the specimens of milk yielded a nearly pure culture of *Bacillus acidi lactici*. When the milk was set aside to sour, many of the alkaline species disappeared as the lactic acid increased in strength. On the other hand, some specimens of milk had so many liquefiers that it was difficult to obtain from the gelatine plate cultures the slowly growing *Bacillus acidi lactici*, which doubtless soured the milk and made it acid, but did not have time to develop before the gelatine was liquefied.

AEROBIC ACID CURDLING ORGANISMS.

Ten different species were isolated, which will be more fully described in a later publication. Nearly all of these were abundant gas producers, both in gelatine and milk. When these were inoculated into sterile milk, they commonly caused much separation of whey and digestion of the curd. A few curdled milk only when grown at 35° C. One species was found in three places in Ohio, and two places in Massachusetts. Some of them produced a typical curdling of milk without subsequent digestion.

CONCLUSION.

It is necessary to repeat more fully the experiments in the territory covered and to obtain data from other places before a valuable, scientific conclusion can be drawn. It is of course possible that the forty-seven organisms isolated are a collection of many species, but the evidence from the data obtained leaves no doubt in my mind that they are the same species.

Milk from thirty widely separated localities in New York, Pennsylvania, Ohio, Maine, New Hampshire, Massachusetts, Rhode Island and Connecticut, yielded, with two exceptions, apparently the same organism. This fact throws the weight of evidence on the side of the belief that one organism universally exists in the territory studied, which produces the ordinary souring and curdling of milk. This organism seems to be identical in every particular with that of Günther and Thierfelder, who concluded that their organism was the same as Lister's *Bacterium lactis* and Hueppe's *Bacillus acidi lactici*.

A STUDY OF RATIONS FED TO MILCH COWS IN CONNECTICUT.

REPORTED BY W. O. ATWATER AND C. S. PHELPS.

The study of rations fed to milch cows on dairy farms in this State, which was begun in the winter of 1892–93, has been repeated each winter since.

Detailed descriptions of the work of the first three winters have been given in the Station publications.* The results of the fourth winter's work (1895–96) are here reported.

Each herd was selected after a personal inspection, or after sufficient correspondence to satisfy ourselves of its fitness for the proposed test, and a representative of the Station was present during the whole period of each test and personally attended to the details of the experiment, such as weighing the feeding stuffs, and taking samples for analyses, and weighing, sampling and determining the butter-fat in the milk. This work was faithfully performed by Mr. C. B. Lane, at that time Assistant Agriculturist to the Station.

In the first winter's work (1892–93), which was regarded as preliminary to an investigation that might extend over a series of years, it was thought better to examine a relatively large number of herds, each during a short period, than to make the periods longer and the number of herds less. Sixteen herds were visited and a five-days' test was made of each.

In the second winter's work (1893–94) six different herds were visited, and in four cases the time of study of the management and products of each herd was extended to twelve days. The analyses of the feeding stuffs were made at once, and the weights of nutrients in the rations as fed were calculated. In three instances other rations were thereupon suggested by us as being better than the ones that had been used. The owners gradually changed the food to the ration thus proposed, and after an interval of four weeks from the close of the

* Reports of this Station for 1893, pp. 69–115; 1894, pp. 26-56; and 1895, pp. 40-76. Bulletin 13 of this Station. Reports of the Connecticut Board of Agriculture, 1893, pp. 182–199; and 1894, pp. 131–146.

5

first test, another twelve-days' test was made of the same herd. A comparison was thus made of the yields of milk and butter-fat with the two different rations.

During the third winter (1894–95) four herds were visited, each herd being under observation for twelve days at two different periods in the same manner as the three herds studied in 1893–94, except that there was only a two-weeks' interval between the two tests on the same herd.

HERD TESTS DURING 1895–96.

During the fourth winter (1895–96) two herds were studied in a similar way, except that in the one case the ration with much larger quantity of protein, and a much narrower nutritive ratio than usual, was used. Samples of the different feeding stuffs used in the tests were taken early in each test and sent to the laboratory for analysis.

In the earlier tests, as soon as it was possible to obtain the results of the analyses, the proportions of nutrients in the ration fed was calculated, and suggestions were made for changes in the ration. After changes had been made and the animals had been upon the new ration for two weeks or longer, the herd was again visited and a new twelve-days' test was made. In the tests during 1895–96 the Station representative stayed at the farm and made the change of ration. In these cases only nine days intervened between the two tests on the same herd, and it became necessary to calculate the first ration from average tables of analyses, as a basis for formulating a new ration. This was done with the idea that it would be best to have the Station make the change of feed. The time proved rather short, however, for making the change, and the present winter (1896–97) we have gone back to the plan of allowing two weeks between tests on the same herd.

The chief points upon which information was obtained were:

Number of animals in the herd.—In considering the number of animals, only those which came into the test were included. Usually these were all of the cows on the farm which were in milk at the time of the test, except those which were nearly dry.

Breed, age, and approximate weight of each cow.—The breed and age were obtained as accurately as possible from the owner. Since it was not practicable to take to the farm scales large

enough on which to weigh the cows, the weights were estimated. This estimate was made in each case by the Station representative, and it is thought that the errors of judgment may run more or less equally through all the herds examined.

Number of months since last calf.—In most cases the time at which the cow dropped her last calf was known.

Number of months till due to calve.—There was, of course, more or less uncertainty in this regard.

Weights of milk-flow for the twelve days of the test.—The milk of each cow at each milking was weighed as soon as milked, to the nearest tenth of a pound, by the Station representative.

Percentages and amounts of butter-fat in the milk.—A sample of the milk of each cow, night and morning, was taken, and from the combined sample a determination of the quantity of butter-fat was made. The Babcock method of fat determination was employed. From the percentages of butter-fat in the milk, and the total weights of the milk, the daily yields of butter-fat were obtained.

Kinds and weights of foods used.—The feeder was requested to use the same kinds and amounts of feeding stuffs during the test period as he had previously been using. The quantity for each animal was weighed by the Station representative just before feeding. Any portions of the food left uneaten by the cows were carefully weighed, and due allowance was made for these uneaten residues in estimating the amounts daily eaten. During the test, usually on the third day, samples of each feeding stuff used were carefully taken and at once sent to the laboratory for analysis. From the results of the analyses and the weights fed, the total nutrients (protein, fat, nitrogen-free extract, and fiber) fed each day were calculated. By the use of digestion coefficients, estimates were made of the weights of digestible nutrients in each day's ration.

The names and post-office addresses of the owners of the herds studied by the Station during the four winters, 1892–93, 1893–94, 1894–95, and 1895–96, are given beyond, on page 64, together with the dates at which the Station representative was at the farm. At the left, in the first column of figures, is a reference number for each test. In the remaining tables, and

in the discussion, the herds entering into the tests and the rations fed are designated by these reference numbers.

The experiments of the winter of 1895–96, which are here reported, were made with herds of:

Mr. Simon Brewster, Jewett City. Test No. 35, December 3–14; and test No. 37, Dec. 22–Jan. 2.

Mr. H. R. Hayden, East Hartford. Test No. 36, Feb. 11–22; and test No. 38, March 6–17.

EXPLANATIONS.

The following brief explanation of nutrients of feeding stuffs and their uses is reprinted from the Report of this Station for 1894:

Uses of food.—The two chief uses of food are to form the materials of the body and make up its wastes, and to yield energy in the form of heat to keep the body warm and in the form of muscular and other power for the work it has to do. The principal tissue-formers of the food are the protein or nitrogenous compounds. They build up and repair the nitrogenous materials, as the muscle and bone, and supply the albuminoids of blood, milk, and other fluids. The chief fuel ingredients of the food are the carbohydrates (such as sugar, starch, etc.,) and fat. These are either consumed in the body or stored as fat to be used as occasion demands.

Fuel value.—The value of food as fuel may be measured in terms of potential energy. The unit commonly used is the calorie. One calorie is the amount of heat necessary to raise the temperature of a pound of water about four degrees Fahrenheit.* From experiment it has been found that a pound of protein or carbohydrates yields, when burned, about 1,860 calories of fuel value, and that a pound of fat yields about 4,220 calories.

Nutritive ratio.—There is a very important relation between the amounts of protein (flesh formers) and the amounts of fuel constituents of a food. This relation is expressed by the nutritive ratio. The fuel value of fat is about two and one-fourth times that of the carbohydrates and the protein, hence it happens that if the sum of the digestible carbohydrates and two and one-fourth times the digestible fat of a ration is divided by the amount of digestible protein in the ration, the quotient gives what is called the nutritive ratio.

Wide ration.—Narrow ration.—If the quantities of digestible fat and carbohydrates are large relative to the protein, the nutritive ratio will be a large number and the ration is called a "wide ration;" if the quantities of digestible fat and carbohydrates are relatively small, the quotient is a small number and the ration is a "narrow" one. A ration where the nutritive ratio is much more than 1:6 may be called a "wide ration;" if much less, it may be called a "narrow ration."

Nearly all of the grasses and hays have a wide nutritive ratio, and the same is true of corn and many of its products, such as meal and hominy chops. The use of such feeding stuffs will tend to make a ration wide. The legumes, such

* The calorie is exactly the heat necessary to raise the temperature of one kilogram of water one degree centigrade. It is equivalent to 1.5 foot tons, or to the mechanical power that would lift 1.5 tons one foot.

as clover, peas, vetch, etc., and many of the products of milling and food manufacture are relatively rich in protein, and hence have narrow nutritive ratios.

The measure of the size of a ration.—In order that a ration may be complete, there must be enough digestible protein supplied in the food to build new tissues (bone, muscle, milk, etc.,) and repair the wastes of the body, and sufficient digestible fat and carbohydrates to furnish heat and muscular energy. As the chief function of the fat and carbohydrates is to serve as fuel, it is more important that enough of these should be provided to meet the needs of the animal than that they should be supplied in definite relative proportions. It is, therefore, possible to form a very good idea of the nutrients furnished in a ration, and to measure its size by the quantity of digestible protein or flesh-formers which it contains, and the fuel value of its digestible constituents.

RESULTS OF THE EXPERIMENTS.

Tables 1 to 8 inclusive contain the results of the observations and studies of the different herds.

The following abbreviations are used in the tables:

Abbreviations used in report of rations fed to milch cows.

G.=Grade. Hol.=Holstein. Jy.=Jersey. Nat.=Native.

The tables are alike in arrangement, and a description of one will serve for all. Each table contains the condensed results of a single test. Table 1, for instance, gives the statistics for herd test No. 35.

The first part of the upper table gives a reference number of each animal, its breed, age, weight, and number of months since last calf. The smallest daily milk flow, the greatest daily milk flow, and the average daily yield of milk for the period of the test are given in the next three columns. In the three following columns are given the lowest, highest, and average percentages of fat found in the daily milk of each cow for the period. The last named figures were obtained by adding together the several daily determinations and taking the average as representing the whole period, hence this actual average is not always half way between the highest and the lowest. The yield of fat is given in the last three columns of the first or upper part of the table. The minimum and maximum yields of fats were obtained by multiplying each day's milk by its percentage of fat; the lowest number thus obtained gives the minimum daily yield of fat, and the largest the maximum yield of fat. It is to be noted that these numbers are not always the same as would have been obtained by multiplying the minimum and maximum daily milk flow by the minimum and maximum percentages of fat.

The lower part of each table gives the kinds and amounts of the different feeding stuffs eaten per day, and the weights of the digestible nutrients (protein, fat and carbohydrates) which they were estimated to furnish. The weights of foods and nutrients are calculated per 1,000 pounds live weight and also "per average weight" of each herd. These last figures, which are given in the last five columns of the table, represent the average amount actually fed per animal.

All of the different feeding stuffs used in these rations were analyzed. From the weights of the different feeding stuffs, the results of the analyses, and the digestion coefficients given in the following table, the weights of digestible nutrients were calculated in the usual way. The fuel value, or potential energy furnished by the different foods, was obtained by multiplying the number of pounds of protein and of carbohydrates by 1,860, and the number of pounds of fat by 4,220, and taking the sum of these three products as the number of calories of potential energy in the materials.

The rations fed in 1895–96 are summarized with those of the three previous winters in table 5.

DIGESTIBILITY OF FEEDING STUFFS.

We have had frequent occasion to insist in the publications of this Station that the estimates of the quantities of nutrients in these rations, and in feeding stuffs generally, are not absolutely accurate unless the feeding stuffs themselves are accurately analyzed, since materials of the same kind vary considerably in composition and the figures ordinarily printed in tables of composition represent only general averages. The same is true of the digestibility of a given amount of protein in a feeding stuff or a ration, a larger or smaller portion may be digested in a given case. The proportion digested will depend upon the digestive powers of the animal and the character of the feeding stuff. The same is true of the fats and carbohydrates. The proportions of each ingredient which are supposed to be actually digested are commonly expressed in percentages, and in that form are designated as coefficients of digestibility.*

* For explanations of these subjects, see articles on digestion experiments, and especially articles on the digestibility of feeding stuffs and the calculation of rations in the Report for 1893, pages 156 and 168.

The coefficients of digestibility used here are given in the following table. They are practically the same as those used in previous reports. They are based upon the results of digestion experiments with domestic animals. Where such experiments have been made in this country, in sufficient number to give reliable results, these are used for the coefficients. In other cases the results of European (and especially German) experiments have been drawn upon for the purpose.

Coefficients of digestibility employed in calculating the digestible nutrients in the different feeding stuffs used in these rations.

Kind.	Protein.	Fat.	Carbohydrates.	
			Nitrogen-free Extract.	Fiber.
	%	%	%	%
Wheat bran,	78*	76*	72*	33†
Linseed meal,	86†	90†	80†	50†
Cotton seed meal,	89*	100*	68*	33†
Wheat middlings,	79*	85*	83*	33†
Corn meal,	76†	92†	87†	58†
Gluten meal,	87*	88*	91*	33†
Good quality hay,	54*	54*	63*	55*
Poor quality hay,	45*	28*	60*	46*
Clover hay,	61*	49*	65*	46*
Oat hay,	53*	61*	52*	43*
Corn stalks (stover),	52*	52*	64*	66*
Potatoes,	44*	13*	91*	—

* From results of American digestion experiments.
† From results of German digestion experiments.

In order to show the range of variation from day to day in the feeding of the same herd, the minimum and maximum daily rations per 1,000 pounds live weight and per average weight of each herd are appended in the tables. The size of the ration is here measured by the fuel value of the digestible nutrients (protein, fat, etc.). A ration which has a large fuel value may have a small amount of a given kind of food or a given kind of nutrients. Hence it sometimes happens that the minimum of one of the nutrients furnished by a certain kind of feeding stuff in a given ration may be greater than the average of the nutrients in that ration. The same may happen conversely, in the case of the maximum.

TABLE I.

Dairy Test No. 35.—Statistics of herd from December 3 to December 14, 1895.

Ref. No.	Breed.	Age.	Weight.	Mos. since Last Calf.	Daily Milk Flow. Min.	Daily Milk Flow. Max.	Daily Milk Flow. Avg.	Daily Percentage of Fat. Min.	Daily Percentage of Fat. Max.	Daily Percentage of Fat. Avg.	Daily Yield of Fat. Min.	Daily Yield of Fat. Max.	Daily Yield of Fat. Avg.
		Yrs.	Lbs.	Mos.	Lbs.	Lbs.	Lbs.	%	%	%	Lbs.	Lbs.	Lbs.
1	Native, -	7	800	2	14.4	16.2	**15.1**	4.7	5.3	**5.1**	.71	.83	**.77**
2	Native, -	7	750	14	10.5	12.7	**11.6**	3.9	5.2	**4.4**	.44	.61	**.51**
3	G. Jy., -	11	765	1	25.2	29.2	**27.4**	2.9	3.6	**3.2**	.77	.96	**.88**
4	G. Jy., -	11	850	3	12.9	14.8	**14.0**	3.4	5.8	**4.3**	.47	.80	**.60**
5	G. Jy., -	10	825	1	16.3	22.3	**20.6**	4.1	6.4	**4.9**	.83	1.63	**1.01**
6	G. Jy., -	10	725	3	13.7	15.4	**14.4**	3.5	5.1	**3.9**	.51	.72	**.56**
7	G. Jy., -	10	675	2	12.1	16.6	**15.1**	3.8	6.3	**4.9**	.58	.98	**.74**
8	Native, -	4	700	2	19.1	21.7	**20.3**	3.0	3.7	**3.3**	.61	.75	**.67**
9	Native, -	12	750	8	7.9	11.6	**9.8**	4.6	5.9	**5.3**	.36	.58	**.52**
10	Native, -	8	775	4	16.6	18.6	**17.5**	3.8	4.9	**4.4**	.65	.85	**.77**
11	Native, -	7	800	4	17.5	19.0	**18.4**	3.8	4.6	**4.2**	.71	.87	**.77**
	Herd avg., -	—	**775**	—	—	—	**16.7**	—	—	**4.3**	—	—	**.72**

Pounds of food and nutrients per day per 1000 pounds, live weight, and per average weight (775 pounds) of herd.

Kinds of Food.	Per 1000 Lbs., Live Weight. Average Fed per Day.	Protein.	Fat.	Carbohydrates.	Nutritive Ratio.	Fuel Value.	Per Average Weight (775 Lbs.) of Herd. Average Fed per Day.	Protein.	Fat.	Carbohydrates.	Fuel Value.
Average per Day.	Lbs.	Lbs.	Lbs	Lbs.	1:	Cal.	Lbs.	Lbs.	Lbs	Lbs.	Cal.
Corn meal, - -	4.1	.29	.20	2.54	—	—	3.2	.22	.15	1.97	—
Wheat bran, - -	2.2	.30	.08	.93	—	—	1.7	.23	.06	.72	—
Wheat middlings, -	3.1	.42	.10	1.67	—	—	2.4	.33	.08	1.29	—
Total conc. food, -	9.4	1.01	.38	5.14	5.9	13050	7.3	.78	.29	3.98	10050
Oat hay, - -	8.7	.36	.19	3.14	—	—	6.8	.28	.15	2.43	—
Corn stover, - -	14.1	.47	.15	6.71	—	—	10.9	.36	.12	5.20	—
Total coarse food, -	22.8	.83	.34	9.85	12.8	21300	17.7	.64	.27	7.63	16550
Total food, -	**32.2**	**1.84**	**.72**	**14.99**	**9.0**	**34350**	**25.0**	**1.42**	**.56**	**11.61**	**26600**
Minimum per Day.											
Concentrated food,	9.2	.99	.38	5.00	5.9	12750	7.1	.77	.30	3.88	9900
Coarse food, - -	18.4	.67	.30	6.70	11.0	14950	14.3	.52	.23	5.19	11600
Total food, -	27.6	1.66	.68	11.70	8.0	27700	21.4	1.29	.53	9.07	21500
Maximum per Day.											
Concentrated food,	8.7	.96	.35	4.71	5.7	12050	6.7	.74	.27	3.65	9300
Coarse food, - -	26.1	.96	.39	11.26	12.6	24350	20.2	.74	.30	8.73	18900
Total food, -	34.8	1.92	.74	15.97	9.2	36400	26.9	1.48	.57	12.38	28200

TABLE 2.

Dairy Test No. 36.—Statistics of herd from February 11 to February 22, 1896.

Ref. No.	Breed.	Age.	Weight.	Mos. since Last Calf.	Daily Milk Flow. Min.	Max.	Avg.	Daily Percentage of Fat. Min.	Max.	Avg.	Daily Yield of Fat. Min.	Max.	Avg.
		Yrs.	Lbs.	Mos.	Lbs.	Lbs.	Lbs.	%	%	%	Lbs.	Lbs.	Lbs.
1	G. Jy., -	6	750	—	13.7	15.9	**14.6**	5.7	6.5	**6.2**	.82	.96	**.90**
2	G. Jy., -	3	675	—	7.8	9.9	**9.1**	5.0	5.9	**5.4**	.39	.54	**.49**
3	G. Hol., -	6	700	—	12.3	13.9	**13.1**	5.4	6.4	**5.9**	.66	.81	**.77**
4	Native, -	5	750	—	11.8	13.2	**12.6**	5.4	5.8	**5.5**	.66	.74	**.69**
5	G. Jy., -	10	925	—	14.4	18.9	**17.4**	4.5	5.9	**5.4**	.65	1.17	**.94**
6	G. Jy., -	6	750	—	21.8	24.0	**22.9**	4.8	6.4	**5.1**	1.07	1.50	**1.16**
7	Native, -	8	825	—	24.4	27.0	**26.2**	4.1	5.0	**4.6**	1.05	1.35	**1.20**
8	G. Jy., -	2	750	—	10.0	11.1	**10.5**	4.4	5.4	**5.1**	.44	.57	**.54**
9	G. Jy., -	7	725	—	22.0	24.0	**22.8**	3.7	4.8	**4.4**	.84	1.15	**1.00**
10	G. Jy., -	2	650	—	7.3	10.9	**10.0**	5.0	5.8	**5.4**	.39	.61	**.54**
11	Native, -	6	725	—	16.7	19.1	**17.9**	4.7	5.9	**5.5**	.85	1.12	**.98**
12	G. Jy., -	7	750	—	16.2	18.5	**17.6**	4.5	5.2	**5.0**	.79	.94	**.88**
13	G. Jy., -	6	725	—	19.9	23.3	**21.7**	4.9	5.5	**5.3**	.98	1.21	**1.15**
14	G. Hol., -	9	750	—	19.8	22.6	**21.1**	4.1	5.8	**4.7**	.81	1.24	**.99**
	Herd avg.,	—	**750**	—	—	—	**17.0**	—	—	**5.3**	—	—	**.87**

Pounds of food and nutrients per day per 1000 pounds, live weight, and per average weight (750 pounds) of herd.

Kinds of Food.	Per 1000 Lbs., Live Weight. Average Fed per Day.	Digestible Nutrients and Fuel Value. Protein.	Fat.	Carbohydrates.	Nutritive Ratio.	Fuel Value.	Per Average Weight (750 Lbs.) of Herd. Average Fed per Day.	Digestible Nutrients and Fuel Value. Protein.	Fat.	Carbohydrates.	Fuel Value.
Average per Day.	Lbs.	Lbs.	Lbs	Lbs.	1:	Cal.	Lbs.	Lbs.	Lbs	Lbs.	Cal.
Grain,* - -	12.6	2.36	.54	5.84	3.0	17500	9.4	1.77	.40	4.38	13150
Hay, 1st quality, -	6.6	.23	.08	3.12	—	—	5.0	.17	.06	2.34	—
Hay, 2d quality, -	6.6	.35	.04	2.69	—	—	5.0	.26	.03	2.02	—
Stover, - - -	9.5	.16	.06	3.84	—	—	7.1	.12	.04	2.88	—
Potatoes, - -	2.7	.03	–	.45	—	—	2.0	.02	–	.34	—
Total coarse food, -	25.4	.77	.18	10.10	13.7	21000	19.1	.57	.13	7.58	15700
Total food, -	**38.0**	**3.13**	**.72**	**15.94**	**5.6**	**38500**	**28.5**	**2.34**	**.53**	**11.96**	**28850**
Minimum per Day.											
Concentrated food,	11.7	2.18	.50	5.42	3.0	16250	8.8	1.64	.37	4.06	12150
Coarse food, - -	24.8	.72	.17	9.85	14.2	20350	18.6	.54	.13	7.39	15300
Total food, -	36.5	2.90	.67	15.27	5.8	36600	27.4	2.18	.50	11.45	27450
Maximum per Day.											
Concentrated food,	12.3	2.30	.53	5.70	3.0	17150	9.2	1.73	.39	4.28	12850
Coarse food, - -	28.8	.88	.20	11.55	14.5	23950	21.6	.66	.15	8.66	17950
Total food, -	41.1	3.18	.73	17.25	6.0	41100	30.8	2.39	.54	12.94	30800

* The grain used was mixed as follows: Wheat bran, 3.7 lbs.; linseed meal, 1.6 lbs.; corn meal, 1.6 lbs.; Buffalo gluten feed, 2.5 lbs. Total, 9.4 lbs. per day per average weight of herd.

TABLE 3.

Dairy Test No. 37.—Statistics of herd from December 22, 1895, to January 2, 1896.

Ref. No.	Breed.	Age.	Weight.	Mos. since Last Calf.	Daily Milk Flow. Min.	Daily Milk Flow. Max.	Daily Milk Flow. Avg.	Daily Percentage of Fat. Min.	Daily Percentage of Fat. Max.	Daily Percentage of Fat. Avg.	Daily Yield of Fat. Min.	Daily Yield of Fat. Max.	Daily Yield of Fat. Avg.
		Yrs.	Lbs.	Mos.	Lbs.	Lbs.	Lbs.	%	%	%	Lbs.	Lbs.	Lbs.
1	Native, -	7	800	2	16.0	18.0	**17.0**	4.7	5.0	**4.9**	.77	.89	**.83**
2	Native, -	7	750	14	11.6	12.5	**12.0**	3.8	4.5	**4.3**	.46	.54	**.52**
3	G. Jy., -	11	765	1	26.4	29.0	**27.2**	3.0	3.9	**3.4**	.84	1.03	**.93**
4	G. Jy., -	11	850	3	12.6	14.5	**14.0**	3.2	5.4	**4.6**	.43	.78	**.64**
5	G. Jy., -	10	825	1	17.5	23.9	**19.9**	3.5	8.1	**5.1**	.62	1.94	**1.02**
6	G. Jy., -	10	725	3	13.9	17.1	**15.0**	3.6	4.8	**4.3**	.55	.82	**.64**
7	G. Jy., -	10	675	2	14.5	17.7	**16.1**	3.8	5.9	**4.7**	.55	1.04	**.76**
8	Native, -	4	700	2	20.3	22.4	**21.2**	3.0	4.3	**3.7**	.65	.90	**.78**
9	Native, -	12	750	8	8.4	12.0	**10.9**	4.2	5.8	**5.1**	.43	.68	**.56**
10	Native, -	8	775	4	16.7	20.0	**18.5**	3.6	4.8	**4.4**	.63	.92	**.81**
11	Native, -	7	800	4	19.4	20.7	**20.0**	3.9	5.3	**4.3**	.78	1.06	**.86**
	Herd avg.,	—	**775**	—	—	—	**17.4**	—	—	**4.4**	—	—	**.77**

Pounds of food and nutrients per day per 1000 pounds, live weight, and per average weight (775 pounds) of herd.

Kinds of Food.	Per 1000 Lbs., Live Weight. Average Fed per Day.	Per 1000 Lbs. Digestible Nutrients and Fuel Value. Protein.	Fat.	Carbohydrates.	Nutritive Ratio.	Fuel Value.	Per Average Weight (775 Lbs.) of Herd. Average Fed per Day.	Per Average Weight Digestible Nutrients and Fuel Value. Protein.	Fat.	Carbohydrates.	Fuel Value.
Average per Day.	Lbs.	Lbs.	Lbs	Lbs.	1:	Cal.	Lbs.	Lbs.	Lbs	Lbs.	Cal.
Gluten meal, - -	4.0	1.15	.27	1.69	—	—	3.1	.89	.21	1.31	—
Wheat bran, - -	2.0	.27	.07	.85	—	—	1.5	.21	.05	.66	—
Wheat middlings, -	2.8	.37	.09	1.52	—	—	2.2	.29	.07	1.18	—
Total conc. food, -	8.8	1.79	.43	4.06	2.8	12700	6.8	1.39	.33	3.15	9850
Clover hay, - -	8.3	.74	.09	3.30	—	—	6.4	.57	.07	2.55	—
Corn stover, - -	11.9	.40	.12	5.66	—	—	9.2	.31	.09	4.39	—
Total coarse food, -	20.2	1.14	.21	8.96	8.2	19700	15.6	.88	.16	6.94	15200
Total food, -	**29.0**	**2.93**	**.64**	**13.02**	**4.9**	**32400**	**22.4**	**2.27**	**.49**	**10.09**	**25050**
Minimum per Day.											
Concentrated food,	8.7	1.78	.43	4.00	2.8	12600	6.8	1.38	.33	3.10	9700
Coarse food, - -	19.6	1.09	.20	8.73	8.4	19100	15.2	.84	.15	6.76	14750
Total food, -	28.3	2.87	.63	12.73	1.49	31700	22.0	2.22	.48	9.86	24450
Maximum per Day.											
Concentrated food,	8.8	1.80	.43	4.08	2.8	12750	6.8	1.39	.33	3.16	9850
Coarse food, - -	21.2	1.21	.23	9.42	8.2	20750	16.4	.94	.18	7.30	16100
Total food, -	30.0	3.01	.66	13.50	5.0	33500	23.2	2.33	.51	10.46	25950

TABLE 4.

Dairy Test No. 38.—Statistics of herd from March 6 to March 17, 1896.

Ref. No.	Breed.	Age.	Weight.	Mos. since Last Calf.	Daily Milk Flow. Min.	Daily Milk Flow. Max.	Daily Milk Flow. Avg.	Daily Percentage of Fat. Min.	Daily Percentage of Fat. Max.	Daily Percentage of Fat. Avg.	Daily Yield of Fat. Min.	Daily Yield of Fat. Max.	Daily Yield of Fat. Avg.
		Yrs.	Lbs.	Mos.	Lbs.	Lbs.	Lbs.	%	%	%	Lbs.	Lbs.	Lbs.
1	G. Jy., -	6	750	—	14.0	15.8	15.1	6.2	6.7	6.4	.91	1.01	.97
2	G. Jy., -	3	675	—	7.8	8.6	8.3	5.8	6.2	6.1	.48	.53	.51
3	G. Hol., -	6	700	—	12.0	13.2	12.7	5.6	6.5	6.1	.68	.84	.77
4	Native, -	5	750	—	12.5	13.5	12.9	5.6	6.3	5.8	.70	.81	.75
5	G. Jy., -	10	925	—	16.4	19.3	17.8	5.2	6.3	5.8	.93	1.14	1.03
6	G. Jy., -	6	750	—	22.1	24.2	23.3	4.7	5.9	5.2	1.04	1.39	1.20
7	Native, -	8	825	—	25.1	27.5	26.5	4.5	5.4	4.8	1.15	1.47	1.27
8	G. Jy., -	2	750	—	10.0	10.8	10.5	5.2	5.8	5.4	.52	.60	.57
9	G. Jy., -	7	725	—	21.9	24.5	23.1	4.1	5.0	4.6	.90	1.24	1.06
10	G. Jy., -	2	650	—	9.4	11.1	10.5	5.3	6.2	5.7	.52	.63	.60
11	Native, -	6	725	—	17.6	20.2	19.4	5.4	6.2	5.8	1.02	1.22	1.13
12	G. Jy., -	7	750	—	17.8	18.8	18.3	5.0	5.6	5.3	.92	1.03	.97
13	G. Jy., -	6	725	—	22.7	23.9	23.3	4.7	5.8	5.5	1.10	1.39	1.28
14	G. Hol., -	9	750	—	21.0	23.0	21.9	4.3	5.6	4.7	.92	1.17	1.04
	Herd avg., -	—	750	—	—	—	17.4	—	—	5.5	—	—	.94

Pounds of food and nutrients per day per 1000 pounds, live weight, and per average weight (750 pounds) of herd.

Kinds of Food.	Per 1000 Lbs., Live Weight. Average Fed per Day.	Digestible Nutrients and Fuel Value. Protein.	Fat.	Carbohydrates.	Nutritive Ratio.	Fuel Value.	Per Average Weight (750 Lbs.) of Herd. Average Fed per Day.	Digestible Nutrients and Fuel Value. Protein.	Fat.	Carbohydrates.	Fuel Value.
Average per Day.	Lbs.	Lbs.	Lbs	Lbs.	1:	Cal.	Lbs.	Lbs.	Lbs	Lbs.	Cal.
Grain,* -	13.6	3.00	.82	5.45	2.4	19200	10.2	2.25	.61	4.09	14400
Hay, 1st quality, -	5.4	.19	.06	2.55	—	—	4.0	.14	.04	1.91	—
Hay, 2d quality, -	5.4	.29	.04	2.20	—	—	4.0	.22	.03	1.65	—
Stover, -	8.8	.15	.05	3.56	—	—	6.7	.11	.04	2.67	—
Potatoes, -	2.7	.03	-	.45	—	—	2.0	.02	-	.34	—
Total coarse food, -	22.3	.66	.15	8.76	13.8	18150	16.7	.49	.11	6.57	13550
Total food, -	**35.9**	**3.66**	**.97**	**14.21**	**4.5**	**37350**	**26.9**	**2.74**	**.72**	**10.66**	**27950**
Minimum per Day.											
Concentrated food,	12.7	2.80	.76	5.10	2.4	17900	9.5	2.10	.57	3.83	13400
Coarse food, -	22.6	.65	.16	8.87	14.2	18400	17.0	.49	.12	6.65	13800
Total food, -	35.3	3.45	.92	13.97	4.7	36300	26.5	2.59	.69	10.48	27200
Maximum per Day.											
Concentrated food,	13.9	3.07	.84	5.57	2.4	19600	10.4	2.30	.63	4.18	14700
Coarse food, -	22.8	.66	.15	8.98	14.1	18600	17.1	.50	.11	6.73	13900
Total food, -	36.7	3.73	.99	14.55	4.5	38200	27.5	2.80	.74	10.91	28600

* The grain used was mixed as follows: Wheat bran, 4.1 lbs.; linseed meal, 1 lb.; corn meal, 1 lb.; Buffalo gluten feed, 2 lbs; cotton seed meal, 2.1 lbs. Total, 10.2 lbs. per day per average weight of herd.

The following list of experiments during four successive winters will serve as a key to table 5 beyond, in which the rations of all the herds studied are briefly summarized:

Names and post-office addresses of owners of herds studied, dates at which they were visited, and reference number of herds.

No. of Herd.	Name and Post-Office Address of Owner.	Date of Test.
	Experiments of Winter of 1892–93.	
1,	W. S. Crane, Willimantic,	Nov. 30–Dec. 2.
2.	N. D. Potter, South Coventry,	Dec. 5–9.
3,	Samuel Stockwell, West Simsbury,	Dec. 12–17.
4,	C. P. Case, Simsbury,	Dec. 19–24.
5.	Edward Manchester, West Winsted,	Dec. 26–31.
6,	Isaac Barnes, Collinsville,	Jan. 2–7.
7.	Elbert Manchester, Bristol,	Jan. 9–14.
8,	Edward Norton, Farmington,	Jan. 16–21.
9,	H. W. Sadd, Wapping,	Jan. 23–28.
10,	John Thompson, Broad Brook,	Jan. 30–Feb. 4.
11,	E. F. Thompson, Warehouse Point,	Feb. 6–11.
12,	R. E. Holmes, West Winsted,	Feb. 13–18.
13,	James B. Blivin, Baltic,	Feb. 27–Mch. 4.
14,	George W. Woodbridge, Manchester Green,	Mch. 6–11.
15,	Harvey S. Ellis, Vernon Center,	Mch. 13–18.
16,	Charles P. Grosvenor, Abington,	Mch. 20–25.
	Experiments of Winter of 1893–94.	
18,	W. S. Crane, Willimantic,	Dec. 4–16.
19,	Harvey S. Ellis, Vernon Center,	Dec. 18–30.
20,	Clifton Peck, Lebanon,	Jan. 2–13.
21,	Same herd as No. 18,	Jan. 15–27.
22,	C. H. Lathrop, North Franklin,	Jan. 29–Feb. 10.
23,	Same herd as No. 20,	Feb. 12–24.
24,	W. F. Maine, South Windham,	Feb. 26–Mch. 3.
25,	Same herd as No. 22,	Mch. 5–17.
26,	Charles G. Nichols, West Willington,	Mch. 19–24.
	Experiments of Winter of 1894–95.	
27,	C. B. Davis, Yantic,	Dec. 10–22.
28,	W. F. Maine, South Windham,	Dec. 24–Jan. 5.
29,	Same herd as No. 27,	Jan. 7–19.
30,	Same herd as No. 28,	Jan. 21–Feb. 2.
31,	I. W. Trowbridge, Putnam,	Feb. 4–16.
32,	R. L. Sadd, Wapping,	Feb. 18–Mch. 2.
33,	Same herd as No. 31,	Mch. 4–16.
34,	Same herd as No. 32,	Mch. 18–30.
	Experiments of Winter of 1895–96.	
35,	Simon Brewster, Jewett City,	Dec. 3–14.
36,	H. R. Hayden, East Hartford,	Feb. 11–22.
37,*	Same as No. 35,	Dec. 22–Jan. 2.
38,	Same as No. 36,	Mch. 6–17.

* A test was begun on another herd January 7th, but during the second period had to be discontinued, and is not reported upon.

TABLE 5.

Summary of total and digestible nutrients fed per day per 1000 pounds, live weight, on dairy farms in Connecticut. Studies of four successive winters, 1892–93, 1893–94, 1894–95, and 1895–96.

Reference No.	Classes of Food.	Total Food.	Organic Matter.	Digestible Nutrients and Fuel Value.				
				Protein.	Fat.	Carbo-hydrates.	Nutritive Ratio.	Fuel Value.
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	1:	Cal.
1	Concentrated food,	8.3	7.2	1.58	.55	3.51	—	11790
	Coarse food,	43.6	18.3	.93	.44	9.73	—	21660
	Total food,	**51.9**	**25.5**	**2.51**	**.99**	**13.24**	**6.2**	**33450**
2	Concentrated food,	11.4	10.0	2.05	.49	5.58	—	16300
	Coarse food,	64.7	17.2	.74	.36	9 61	—	20700
	Total food,	**76.1**	**27.2**	**2.79**	**.85**	**15.19**	**6.1**	**37000**
3	Concentrated food,	10.7	9.4	2.39	.87	4.65	—	16770
	Coarse food,	27.9	17.5	.62	.28	10.13	—	21180
	Total food,	**38.6**	**26.9**	**3.01**	**1.15**	**14.78**	**5.7**	**37950**
4	Concentrated food,	10.6	9.2	1.47	.46	4.99	—	14000
	Coarse food,	30.5	22.0	1.15	.47	11.67	—	25800
	Total food,	**41.1**	**31.2**	**2.62**	**.93**	**16.66**	**7.0**	**39800**
5	Concentrated food,	8.2	7.2	2.20	.76	2.64	—	12200
	Coarse food,	46.3	22.4	.96	.49	12.55	—	27200
	Total food,	**54.5**	**29.6**	**3.16**	**1.25**	**15.19**	**5.7**	**39400**
6	Concentrated food,	7.5	6.5	1.23	.51	3.58	—	11100
	Coarse food,	26.6	20.1	.80	.36	10.97	—	23400
	Total food,	**34.1**	**26.6**	**2.03**	**.87**	**14.55**	**8.1**	**34500**
7	Concentrated food,	14.1	12.2	1.44	.65	7.70	—	19740
	Coarse food,	24.4	19.8	1.00	.44	10.30	—	22860
	Total food,	**38.5**	**32.0**	**2.44**	**1.09**	**18.00**	**8.4**	**42600**
8	Concentrated food,	12.2	10.4	1.60	.50	5.35	—	15050
	Coarse food,	28.7	23.3	1.56	.43	11.60	—	26300
	Total food,	**40.9**	**33.7**	**3.16**	**.93**	**16.95**	**6.0**	**41350**
9	Concentrated food,	7.4	6.3	1.20	.58	3.14	—	10500
	Coarse food,	22.2	16.5	.96	.25	8.91	—	19450
	Total food,	**29.6**	**22.8**	**2.16**	**.83**	**12.05**	**6.4**	**29950**

TABLE 5.—*(Continued.)*

Reference No.	Classes of Food.	Total Food.	Organic Matter.	Digestible Nutrients and Fuel Value. Protein.	Fat.	Carbo-hydrates.	Nutritive Ratio.	Fuel Value.
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	1:	Cal.
10	Concentrated food,	8.2	7.0	1.09	.50	3.72	—	11100
	Coarse food,	22.3	17.4	1.23	.34	9.32	—	21000
	Total food,	**30.5**	**24.4**	**2.32**	**.84**	**13.04**	**6.4**	**32100**
11	Concentrated food,	10.2	8.9	1.91	.70	4.17	—	14250
	Coarse food,	22.6	17.5	.85	.31	9.29	—	20200
	Total food,	**32.8**	**26.4**	**2.76**	**1.01**	**13.46**	**5.7**	**34450**
12	Concentrated food,	13.1	11.1	2.29	.56	4.84	—	15650
	Coarse food,	48.5	12.3	.70	.38	6.57	—	15100
	Total food,	**61.6**	**23.4**	**2.99**	**.94**	**11.41**	**4.5**	**30750**
13	Concentrated food,	11.2	9.7	1.67	.64	5.27	—	15600
	Coarse food,	38.2	10.8	.53	.28	5.90	—	13150
	Total food,	**49.4**	**20.5**	**2.20**	**.92**	**11.17**	**6.0**	**28750**
14	Concentrated food,	9.4	8.4	1.71	.64	3.79	—	12900
	Coarse food,	22.3	17.8	.95	.41	9.30	—	20850
	Total food,	**31.7**	**26.2**	**2.66**	**1.05**	**13.09**	**5.8**	**33750**
15	Concentrated food,	8.8	7.5	.70	.37	4.79	—	11800
	Coarse food,	20.3	16.3	.65	.19	9.20	—	19100
	Total food,	**29.1**	**23.8**	**1.35**	**.56**	**13.99**	**11.3**	**30900**
16	Concentrated food,	6.9	6.0	.61	.46	3.74	—	10100
	Coarse food,	21.7	16.8	.83	.34	8.92	—	19500
	Total food,	**28.6**	**22.8**	**1.44**	**.80**	**12.66**	**9.3**	**29600**
18	Concentrated food,	12.3	10.6	1.80	.55	5.61	3.9	16100
	Coarse food,	32.2	20.0	.80	.45	10.84	15.0	23600
	Total food,	**44.5**	**30.6**	**2.60**	**1.00**	**16.45**	**7.3**	**39700**
19	Concentrated food,	10.7	9.2	2.00	.68	4.65	3.2	15200
	Coarse food,	18.9	15.3	.70	.25	8.48	13.0	18100
	Total food,	**29.6**	**24.5**	**2.70**	**.93**	**13.13**	**5.7**	**33300**
20	Concentrated food,	12.1	10.6	1.22	.39	6.42	6.1	15800
	Coarse food,	24.5	17.6	.75	.25	8.67	12.4	18600
	Total food,	**36.6**	**28.2**	**1.97**	**.64**	**15.09**	**8.5**	**34400**

TABLE 5.—*(Continued.)*

Reference No.	Classes of Food.	Total Food.	Organic Matter.	Digestible Nutrients and Fuel Value. Protein.	Fat.	Carbo-hydrates.	Nutritive Ratio.	Fuel Value.
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	1:	Cal.
* 21	Concentrated food, -	12.5	10.8	2.19	.59	5.15	3.0	16100
	Coarse food, - -	29.9	16.4	.71	.40	8.88	13.9	19500
	Total food, - -	**42.4**	**27.2**	**2.90**	**.99**	**14.03**	**5.7**	**35600**
22	Concentrated food, -	10.0	8.6	1.06	.29	5.05	5.4	12600
	Coarse food, - -	16.4	14.3	.85	.27	7.46	9.6	16600
	Total food, - -	**26.4**	**22.9**	**1.91**	**.56**	**12.51**	**7.3**	**29200**
* 23	Concentrated food, -	11.8	10.3	1.96	.42	5.38	3.3	15400
	Coarse food, - -	22.8	16.5	.72	.24	8.17	12.2	17550
	Total food, - -	**34.6**	**26.8**	**2.68**	**.66**	**13.55**	**5.7**	**32950**
24	Concentrated food, -	13.6	11.5	1.97	.51	6.54	4.0	18000
	Coarse food, - -	20.4	16.8	1.51	.31	8.28	6.0	19500
	Total food, - -	**34.0**	**28.3**	**3.48**	**.82**	**14.82**	**4.8**	**37500**
* 25	Concentrated food, -	10.8	9.3	1.60	.40	5.06	3.8	14100
	Coarse food, - -	16.8	14.7	.88	.31	7.48	9.4	16800
	Total food, - -	**27.6**	**24.0**	**2.48**	**.71**	**12.54**	**5.8**	**30900**
26	Concentrated food, -	10.6	8.6	1.95	.83	4.16	3.2	14900
	Coarse food, - -	14.3	12.0	.57	.22	6.31	12.1	13700
	Total food, - -	**24.9**	**20.6**	**2.52**	**1.05**	**10.47**	**5.2**	**28600**
27	Concentrated food, -	15.2	13.2	1.65	.58	8.15	5.7	20700
	Coarse food, - -	21.2	12.9	.50	.18	7.51	15.8	15650
	Total food, - -	**36.4**	**26.1**	**2.15**	**.76**	**15.66**	**8.0**	**36350**
28	Concentrated food, -	14.5	12.9	1.41	.49	8.12	6.5	19750
	Coarse food, - -	20.3	17.8	.77	.32	10.13	14.1	21100
	Total food, - -	**34.8**	**30.7**	**2.18**	**.81**	**18.25**	**9.2**	**40850**
* 29	Concentrated food, -	20.7	17.9	2.97	.69	9.20	3.6	25550
	Coarse food, - -	16.2	13.8	.51	.17	8.08	16.6	16700
	Total food, - -	**36.9**	**31.7**	**3.48**	**.86**	**17.28**	**5.5**	**42250**
* 30	Concentrated food, -	11.9	10.1	1.67	.35	5.68	3.9	15150
	Coarse food, - -	17.8	14.9	.74	.24	8.43	12.1	18100
	Total food, - -	**29.7**	**25.0**	**2.41**	**.59**	**14.11**	**6.4**	**33250**

* Rations suggested by the Station, see page 74.

TABLE 5.—*(Continued.)*

Reference No.	Classes of Food.	Total Food.	Organic Matter.	Digestible Nutrients and Fuel Value. Protein.	Fat.	Carbo-hydrates.	Nutritive Ratio.	Fuel Value.
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	1:	Cal.
31	Concentrated food,	8.2	7.1	.90	.29	3.93	5.1	10250
	Coarse food,	55.2	16.9	.75	.53	9.64	14.4	21550
	Total food,	**63.4**	**24.0**	**1.65**	**.82**	**13.57**	**9.3**	**31800**
32	Concentrated food,	10.4	9.3	2.18	1.08	4.18	3.0	16400
	Coarse food,	18.3	15.0	.58	.28	8.51	15.8	18100
	Total food,	**28.7**	**24.3**	**2.76**	**1.36**	**12.69**	**5.7**	**34500**
* 33	Concentrated food,	11.0	9.5	1.43	.55	4.99	4.4	14250
	Coarse food,	19.6	16.3	1.36	.39	8.14	6.6	19300
	Total food,	**30.6**	**25.8**	**2.79**	**.94**	**13.13**	**5.5**	**33550**
* 34	Concentrated food,	10.2	9.0	2.05	.82	3.94	2.8	14600
	Coarse food,	20.4	15.9	.74	.29	8.95	13.0	19250
	Total food,	**30.6**	**24.9**	**2.79**	**1.11**	**12.89**	**5.5**	**33850**
35	Concentrated food,	9.4	8.1	1.01	.38	5.14	5.9	13050
	Coarse food,	22.8	19.0	.83	.34	9.85	12.8	21300
	Total food,	**32.2**	**27.1**	**1.84**	**.72**	**14.99**	**9.0**	**34350**
36	Concentrated food,	12.6	11.1	2.36	.54	5.84	3.0	17500
	Coarse food,	25.4	18.6	.77	.18	10.10	13.7	21000
	Total food,	**38.0**	**29.7**	**3.13**	**.72**	**15.94**	**5.6**	**38500**
* 37	Concentrated food,	8.8	7.8	1.79	.43	4.06	2.8	12700
	Coarse food,	20.2	17.0	1.14	.21	8.96	8.2	19700
	Total food,	**29.0**	**24.8**	**2.93**	**.64**	**13.02**	**4.9**	**32400**
* 38	Concentrated food,	13.6	11.9	3.00	.82	5.45	2.4	19200
	Coarse food,	22.3	16.0	.66	.15	8.76	13.8	18150
	Total food,	**35.9**	**27.9**	**3.66**	**.97**	**14.21**	**4.5**	**37350**
	Average of the above 38 Rations.							
	Concentrated food,	10.8	9.3	1.67	.55	4.95	3.7	14650
	Coarse food,	25.9	16.4	.82	.31	8.83	11.6	19250
	Total food,	**36.7**	**25.7**	**2.49**	**.86**	**13.78**	**6.3**	**33900**
	*Average of 29 of the above Rations.**							
	Concentrated food,	10.3	8.9	1.54	.55	4.80	3.9	14100
	Coarse food,	27.6	16.6	.82	.32	8.96	11.8	19550
	Total food,	**37.9**	**25.5**	**2.36**	**.87**	**13.76**	**6.7**	**33650**

* Nine of the above rations (Nos. 21, 23, 25, 29, 30, 33, 34, 37, and 38) were suggested by the Station, as explained on page 53. Hence the twenty-nine other rations, the average of which is here given, actually represent the feeding practice of these dairymen.

Table 5 on pages 65 to 68, gives a summary of 38 rations used in feeding the dairy herds studied by the Station. Nine of these rations were, however, suggested by the Station, and therefore only 29 of them actually represent the feeding practice of these dairymen.

The total weights of food fed per 1,000 pounds live weight are given in the first column of figures. As explained above, all of the foods used in these experiments were carefully analyzed and their chemical composition is therefore known. The weights of digestible nutrients were obtained by the use of factors (digestion coefficients), as explained on page 58. The last column but one contains the nutritive ratio, and the last column gives the calculated fuel value of the digestible nutrients in the rations.

It is possible to compare different rations by the quantities of digestible protein or flesh formers which they contain and the fuel value of their digestible nutrients. The extremes of these rations are pointed out in the following table, by comparing the maximum and minimum of organic matter, protein, fat, carbohydrates, fuel value, and nutritive ratio of all the rations in each case:

	Organic Matter.	Digestible Protein.	Digestible Fat.	Digestible Carbohydrates.	Fuel Value of Digestible Nutrients.	Nutritive Ratio.
	Lbs.	Lbs.	Lbs.	Lbs.	Calories.	1:
Minimum, 27 rations,	20.5	1.35	.56	10.47	28600	4.5
Maximum, 27 rations,	33.7	3.48	1.36	18.25	42600	11.3
Average, 27 rations,	25.5	2.36	.87	13.76	33650	6.7

RATIONS FOR MILCH COWS.

A proper ration for an animal must supply the materials needed for the maintenance of its body and for the production demanded from it.

The amounts and proportions of these nutrients needed for the physiological demands will vary with the animal and with the kind and amount of production. For maintenance the body needs certain amounts of material, chiefly protein, to build its tissues and keep them in repair, and certain amounts of other materials, chiefly carbohydrates and fats, to serve as fuel for supplying the energy which the body needs for heat and work. For growth, the proportion of protein must be liberal. For

6

fattening, there must also be a liberal amount of protein if the increase of "flesh," so-called, is to include any considerable amount of lean, though in many cases, and especially with some breeds of swine, a large amount of fat can be stored in the body from fats and even from carbohydrates in the food. For muscular work, the ratio of protein to fuel ingredients may vary with the amount and intensity of the work, but it appears from the results of the latest and most reliable experimenting that for the intenser forms of muscular work considerable protein is necessary, although the fats and carbohydrates are the chief sources of fuel for the animal machine, and more of them is needed in proportion as more of the muscular work is done.

For the production of milk, the need of a liberal proportion of protein in the food is becoming more and more apparent as accurate experiments and observations accumulate. Just why so much protein is necessary, physiology is not yet able to explain clearly and in detail. But it is not easy to see how any one can look through the evidence which has accumulated, during the last twenty years, without being impressed by the importance which the protein of food plays in milk production. In the Reports and Bulletins of this Station the need of protein in the feed of milch cows has been constantly insisted upon. In the previous accounts of the experiments of the series here discussed this principle has been brought out very clearly. In general the best milk production has been found where the most protein has been fed, and in several instances where the farmers have been feeding rather wide rations and afterwards changed to narrower rations by increasing the protein, an improvement in the milk production was manifest. Naturally there have been some apparent exceptions, as is always to be expected where the periods of observation are so short as this. But as a rule liberal rations with abundant protein and narrow nutritive ratios and large amounts of milk, and milk rich in fat as well as protein, have gone together. So true is this that we feel justified in speaking even more emphatically than we did at the outset of the value of nitrogenous feeding stuffs in the dairy.

Just what weights of different food constituents are best for a given herd or for a given cow on a given farm cannot be told with certainty. As we have frequently insisted, it is impossible to lay down hard and fast rules for feeding.

Still it is possible to set up certain feeding standards which may be followed with more or less actual advantage to the feeder.

TABLE 6.

Rations as fed by dairymen, and proposed standards. Digestible nutrients, per 1000 pounds live weight, daily.

RATION.	Organic Matter.	Protein.	Fat.	Carbo-hydrates.	Fuel Value.	Nutritive Ratio.
	Lbs.	Lbs.	Lbs.	Lbs.	Cal.	1:
Rations as fed by Dairymen:						
Average of 128 American rations,*	24.5	2.15	.74	13.27	31250	6.9
Average of 29 rations as fed in Connecticut, 1892–96, - -	25.5	2.36	.87	13.76	33650	6. 7
Average of 9 rations suggested by Storrs Station and fed in Connecticut, 1892–96, - -	26.4	2.90	.83	13.86	34700	5.4
Standard rations:						
Ration as tentatively suggested by Storrs Station, - -	25.0	2.5	(.5 to .8)	(13 to 12)	31000	5.6
Wolff's (German) standard, -	24.0	2.5	.4	12.5	29600	5.4
Lehmann's (German) standards for cows with different milk yields—Milk per cow per day:						
5 kilos or 11 pounds, -	25.0	1.6	.3	10.0	22850	6.7
7½ kilos or 16½ pounds, -	27.0	2.0	.4	11.0	25850	6.0
10 kilos or 22 pounds, -	29.0	2.5	.5	13.0	30950	5.7
12½ kilos or 27½ pounds, -	32.0	3.3	.8	13.0	33700	4.5

The table above gives a number of results of observations as to the rations actually fed by dairymen, and with them several feeding standards for milch cows. They are intended to show the amounts of nutrients in the food per day and per thousand pounds of live weight of the animal. In each case the quantities represent the digestible nutrients and the fuel value of the daily ration.

The first represents the average of 128 rations compiled by the Wisconsin Experiment Station.* The figures for the amounts of foods in these rations were obtained in response to letters sent to "dairy farmers and breeders of dairy stock in all parts of the United States and Canada, asking information concerning their methods of feeding milch cows." The quantities of food as given by the individual feeders were based

* Wisconsin Experiment Station, Bulletin 38.

generally upon their estimates rather than upon actual weighings of the amounts fed each day to the cows. The quantities of digestible nutrients were calculated from average analyses and from assumed figures for digestibility of each class of nutrients. The average of these rations indicates the use of less protein and more fuel ingredients of food by these intelligent farmers and breeders than the commonly quoted feeding standards call for. This, however, is not at all unnatural.

The relative abundance and cheapness of feeding stuffs containing the fats, and especially carbohydrates, has doubtless led to their very extensive use in this country, but the fact that intelligent men feed them liberally does not imply, and much less does it prove, that we are using them wisely.

The second average in the table is that of twenty-nine studies of the feeding practice of Connecticut dairymen, here reported. It will be observed that they are, on the whole, more liberal and, especially, that they contain considerably larger proportions of protein than the average of the larger number of rations compiled by the Wisconsin Station.

The next ration represents the average of nine which were suggested by the Station to farmers as the result of observations upon their actual feeding practice. In each of these cases, a study was first made of the materials fed and the milk produced. A change in the ration was then suggested by the Station and adopted by the owner of the herd. This change consisted partly in using more nitrogenous feeding stuffs and partly in replacing the finer and more valuable kinds of hay by coarser and cheaper fodder, as explained in detail in the accounts of the experiments. In general the new rations with the larger amounts of protein and narrower nutritive ratios were found decidedly advantageous, as will be explained beyond.

The next is a feeding standard tentatively suggested by the Station. This, it will be observed, contains the same amount of protein as is called for in the German standard by Wolff, which follows next in the table. The amounts of fuel ingredients are, however, a little larger, so that the fuel value is 31,000 calories as compared with 29,600 in the German standard ration. While the German figures probably come nearer to the physiological demand for the average milch cow, especially if the amount of milk is to be at all considered, this more liberal

supply of carbohydrates and wider nutritive ratio was suggested in view of the important practical fact that carbohydrates and fats are relatively cheap and protein dear in Connecticut.

The next is the standard proposed by the German physiological chemist and experimenter, Wolff. It is one of the standards of which a considerable number, for animals of different kinds, were proposed by this eminent authority a number of years ago and have been quoted very extensively by writers upon the subject in Europe and in this country during the past twenty years. Like the other standards proposed by Wolff, Kühn, Lehmann, and others in Germany, and by other investigators and writers elsewhere, it is meant simply as a general indication of the amounts and proportions of nutrients fitted for the average animal of the kind, and under average conditions. It was understood and constantly insisted upon by these writers that the best proportions in a given case would vary with the conditions of that particular case,* and that the proper thing for the farmer to do is to study carefully what feeding stuffs he has and can buy, how much they will cost, how his cows actually respond to different kinds and amounts of fodder, and simply make these feeding standards one of the factors of his estimate of what will be best for him to feed.

The remaining German standards in the table are by Dr. Lehmann, a German authority on these subjects. They are published in the well-known German farmers' almanac, *Mentzel und v. Lengerke's landwirtschaftlicher Kalender*, for 1897, and indicate the drift of opinion in Germany where these subjects are studied more thoroughly than anywhere else in the world.

It may be said by way of explanation that for many years this farmers' almanac has contained, with other things, Wolff's tables of the composition and digestibility of feeding stuffs and feeding standards. These almanacs (or pocket diaries) are in constant use by tens of thousands of the German farmers and feeders, and the statistics which they contain, including those for feeding, are intended to represent what will be, practically, most useful to the feeder. To this end Prof. Wolff has, for more than a quarter of a century past, continually altered them in accordance with the teachings of experience and experimenting. Prof. Wolff has lately died and Dr. Lehmann in continuing

* See discussion of this subject in the Report of this Station for 1894, pp. 205-216.

his work has made some changes in the feeding standards to fit them to the later experience of experimenters and feeders. In the standard for milch cows, particularly, he has attempted to give numerical expression to a fact which has forced itself more and more into view, that the ration should be fitted to the amount of milk given by the cows. In thus attempting to calculate rations for different daily milk yields, Dr. Lehmann has increased the protein more than the fuel ingredients, that is to say, he has made the ration narrower in proportion as the milk yield is larger. This is in accordance with the principle above referred to, that a cow needs a liberal amount of protein to produce a large amount of milk.

Really, there are two principles which underlie this view of the subject. One is that with the improvement of breeds during the last twenty-five years or more there has been a great increase in the amount of milk produced by cows. The standard for milk production of a cow, if we may use the expression, has during this time been constantly rising. Supposing the need for maintenance of the cow's body to remain the same, the extra material needed for milk production has been, consequently, increasing, and hence a larger ration ought to be assigned for a high-bred milk-producing cow to-day than for the cow of twenty-five years ago. The other is that the food for the production of milk over and above that for maintenance needs to be rich in protein. On these two principles rests the theory expressed in the large rations with large amounts of protein and narrow nutritive ratios for large milk production by cows.

Just as it is useless to lay down hard and fast rules for feeding, or exact figures for standard rations, so it is impossible to make categorical statements which shall be true in every particular. What has just been said, therefore, about liberal rations, and about large amounts of protein and narrow nutritive ratios for milch cows, is to be taken just as it is meant, namely, as a general statement of a general principle and nothing more.

THE EXPERIMENTS OF THE WINTER OF 1895–96.

The cost of the feeding stuffs, the pecuniary results of the experiments, the rations fed, and the physiological effects resulting from their use are briefly discussed in the following pages.

The figures used for estimating the values of the feeding stuffs, *i. e.*, the market prices per ton and the values of manure obtainable from one ton of each of the feeding stuffs are stated in the accompanying table:

Valuation of feeding stuffs as used in rations fed milch cows in winter of 1895–96.

FEEDING STUFFS.	Market Price per Ton of Feeding Stuffs.	Estimated Value of the Manure Obtainable from One Ton of Feeding Stuffs.
Wheat bran,	$13.00	$12.00
Wheat middlings, No. 1,	14.00	10.00
Cotton seed meal,	23.00	23.00
Buffalo gluten feed,	14.00	12.00
Chicago gluten meal,	18.00	15.00
O. P. linseed meal,	22.00	19.00
Corn meal,	14.00	7.00
Hay, 1st quality,	16.00	6.00
Hay, 2d quality,	12.00	6.00
Oat hay,	12.00	6.00
Corn stover,	8.00	5.00
Clover hay,	14.00	9.00
Potatoes, small,	10c. per bu.	—

The prices of the feeding stuffs used in calculating the cost of rations were those current in November, 1896. They were obtained, in the case of the grain feeds, by sending circulars to grain dealers in five Connecticut cities asking the current prices of grains in ton lots, and averaging the figures thus obtained. The coarse fodders are based upon the market value of the various materials as estimated by farmers. The manurial value is based upon figures given in the Report of the Massachusetts Agricultural Experiment Station for 1893, pp. 358–365. The nitrogen in the feeding stuff is counted as worth 17½ cents, the phosphoric acid at 5 cents, and the potash at 5½ cents per pound for manure, and it is assumed that 85 per cent. of the quantities in the food may be saved in the manure. Unfortunately, most farmers take such poor care of the manure produced from the materials fed to their stock, that a much smaller percentage is usually saved.

DAIRY HERD H.—TESTS 35 AND 37.

The dairy herd represented in these tests was studied December 3–14, 1895. After an interval of nine days, during which the Station representative made the change of feed, the same

herd was again studied December 22, 1895–January 2, 1896. There were eleven animals in each test, the cows being the same in both. Five of the animals were grade Jerseys, and the rest were natives. The average estimated weight was 775 pounds, and the average age nine years. At the date of the first test the average time since last calf was four months. The rations fed are shown in the table herewith. The main change made in the second ration was the substitution of clover hay and Chicago gluten meal for the oat hay and corn meal fed in the first ration. This narrowed the nutritive ratio from 1:9 to about 1:5, and, of course, increased the proportion of protein.

Dairy Herd H.—Tests 35 and 37.—Calculated per head of 775 pounds, live weight.

Feeding Stuffs.		Digestible Nutrients and Fuel Value.							
Kind.	Amount.	Protein.	Fat.	Carbo-hydrates.	Fuel Value.	Nutritive Ratio.	Cost.	Value of Obtainable Manure.	Net Cost.
First Test. *Dec. 3 to Dec. 14, 1895. 12 Days.*	Lbs.	Lbs.	Lbs.	Lbs.	Cal.	1:	Cts.	Cts.	Cts.
Grain, etc., Corn meal,	3.2								
Wheat bran,	1.7	.78	.29	3.98	10050	5.9	6.5	4.2	2.3
Wheat middlings,	2.4								
Hays, etc., Oat hay,	6.8	.64	.27	7.63	16550	12.8	10.8	6.1	4.7
Corn stover,	10.9								
Total food,	**25.0**	**1.42**	**.56**	**11.61**	**26600**	**9.0**	**17.3**	**10.3**	**7.0**
Second Test. *Dec. 22,'95, to Jan. 2,'96. 12 Days.*									
Grain, etc., Gluten meal,	3.1								
Wheat bran,	1.5	1.39	.33	3.15	9850	2.8	6.9	5.6	1.3
Wheat middlings,	2.2								
Hays, etc., Clover hay,	6.4	.88	.16	6.94	15200	8.2	10.5	6.7	3.8
Corn stover,	9.2								
Total food,	**22.4**	**2.27**	**.49**	**10.09**	**25050**	**4.9**	**17.4**	**12.3**	**5.1**

The total cost of the ration remained practically the same, but the net cost was greatly reduced in the second test, owing to the higher value of the manure. The average daily yield of milk was increased during the second test seven-tenths of a pound and the butter five-hundredths of a pound over that obtained in the first test. The total cost of feed to produce 100 pounds of milk was reduced four cents, and the cost of feed for a pound of butter was reduced two cents, in the second test.

DAIRY HERD I.—TESTS 36 AND 38.

This herd was studied February 11–22, and again March 6–17, 1896. There were fourteen animals in each test, the cows being the same in both. They consisted of nine grade Jerseys, two grade Holsteins, and three natives. The average weight of the herd was estimated at 750 pounds, and the average age six years. The ration fed in the first test was an exceptionally heavy one, and the nutritive ratio was very nearly that of the standard suggested by the Station. In order to study the effect of large quantities of protein, and a narrower nutritive ratio, the quantity of protein was increased from 2.34 pounds to 2.74 pounds per day per cow. In the second test the average quantity of milk was increased four-tenths of a pound, and the quantity of butter seven-hundredths of a pound per day. By reference to the tables on pages 61 and 63 it will be seen that the fat was increased in the second test from two to five-tenths of a per cent. in the case of nearly every cow.

Dairy Herd I.—Tests 36 and 38.—Calculated per head of 750 pounds, live weight.

Feeding Stuffs.			Digestible Nutrients and Fuel Value.							
Kind.		Amount.	Protein.	Fat.	Carbohydrates.	Fuel Value.	Nutritive Ratio.	Cost.	Value of Obtainable Manure.	Net Cost.
		Lbs.	Lbs.	Lbs.	Lbs.	Cal.	1:	Cts.	Cts.	Cts.
First Test. *Feb. 11 to Feb. 22, 1896. 12 Days.*										
Grain, etc.,	Wheat bran,	3.7								
	Linseed meal,	1.6								
	Corn meal,	1.6	1.77	.40	4.38	13150	3.0	9.5	7.7	1.8
	Buff. gluten meal,	2.5								
Hays, etc.,	Hay, 1st quality,	5.0								
	Hay, 2d quality,	5.0								
	Stover,	7.1	.57	.13	7.58	15700	13.7	13.5	6.4	7.1
	Potatoes,	2.0								
Total food,		**28.5**	**2.34**	**.53**	**11.96**	**28850**	**5.6**	**23.0**	**14.1**	**8.9**
Second Test. *Mar. 6 to Mar. 17, 1896. 12 Days.*										
Grain, etc.,	Wheat bran,	4.1								
	Linseed meal,	1.0								
	Corn meal,	1.0	2.25	.61	4.09	14400	2.4	10.3	8.7	1.6
	Buff. gluten meal,	2.0								
	Cotton seed meal,	2.1								
Hays, etc.,	Hay, 1st quality,	4.0								
	Hay, 2d quality,	4.0								
	Stover,	6.7	.49	.11	6.57	13550	13.8	11.4	5.4	6.0
	Potatoes,	2.0								
Total food,		**26.9**	**2.74**	**.72**	**10.66**	**27950**	**4.5**	**21.7**	**14.1**	**7.6**

The total cost of each of the rations was large, although the second ration was slightly less expensive than the first. Quite a number of cows in the herd were well along in the period of lactation, and were no doubt being fed too heavily for the amount of product they were giving. It is very interesting to note that the experiment seems to corroborate results obtained at the Massachusetts and Pennsylvania Experiment Stations* in showing that heavy protein rations, if any, are the ones that tend to increase the percentage of fat in the milk.

COMPARISON OF TESTS WITH WIDER AND NARROWER RATIONS.

The experiments of the last three seasons—1893–94, 1894–95 and 1895–96—include nine cases in which comparative tests were made by feeding two different rations in succession to the same herd, in the manner described above, pages 53 and 54. In each case the ration actually being fed in the ordinary method practiced on the farm was determined by weighing the feeding stuffs on the spot as they were fed and taking samples for analyses, and at the same time weighing the milk of each cow and determining the percentage of butter-fat. As soon as the analyses of the feeding stuffs could be made, so as to calculate the amounts of nutrients, another ration was made up which was assumed to be a nearer approach to the accepted standards and a second test was made with this ration, the fodder and milk being weighed and analyzed as before. In eight of the cases the second ration was narrower than the first; in one instance the first ration was comparatively narrow, and the change was mainly from more to less expensive food materials. The length of each test was twelve days. The interval between the two tests of each comparative trial was from two to four weeks in the seven comparative experiments of 1893–94 and 1894–95, and nine days in the two of 1895–96.

The results of the eighteen tests with nine herds are summarized in the following table. The rations fed each herd in the different tests, the cost of the rations, the daily milk and butter product, and the cost of food to produce 100 pounds of milk and one pound of butter, are given in such a way that the results from the two rations can be easily compared.

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* Massachusetts State Station Report, 1894, p. 43; Pennsylvania Experiment Station Report, 1895, p. 71.

Summary of daily rations fed, and daily milk and butter yield from nine herds with a wide as compared with a narrower ration.

Herd.		Average Weight of Cows.	No. of Test.	Daily Ration per Head. Digestible Protein.	Fuel Val. of Digestible Nutrients.	Nutritive Ratio.	Total Cost.	Net Cost.*	Average Daily Milk Flow.	Yield of Butter.†	Cost of Food to Produce 100 lbs. Milk. Total Cost.	Net Cost.*	1 lb. Butter. Total Cost.	Net Cost.*
		Lbs.		Lbs.	Cal.	1:	Cts.	Cts.	Lbs.	Lbs.	$	Ct	Ct	Ct
A	Wide ration,	825	18	2.15	32750	7.3	26.6	14.3	18.1	1.10	1.47	79	24	13
	Nar. ration,		21	2.39	29400	5.7	21.7	9.8	18.9	1.12	1.15	52	19	9
B	Wide ration,	750	20	1.49	25800	8.5	18.6	9.5	18.1	.90	1.00	53	21	11
	Nar. ration,		23	2.01	24700	5.7	18.3	9.0	17.9	.92	1.03	50	20	10
C	Wide ration,	725	22	1.38	21150	7.3	19.4	12.5	13.7	.67	1.41	91	29	19
	Nar. ration,		25	1.80	22400	5.7	17.8	9.9	13.6	.71	1.30	73	25	14
D	Wide ration,	600	27	1.29	21800	8.0	14.1	7.0	14.0	.79	1.01	50	18	9
	Nar. ration,		29	2.09	25350	5.5	15.1	6.9	13.7	.76	1.10	50	20	9
E	Wide ration.	750	28	1.63	30650	9.2	18.4	10.5	17.9	1.02	1.03	59	18	10
	Nar. ration,		30	1.81	24950	6.4	15.9	7.1	18.3	1.07	.87	39	15	7
F	Wide ration,	800	31	1.32	25450	9.3	15.1	6.8	17.8	1.01	.85	38	15	7
	Nar. ration,		33	2.23	26850	5.5	18.0	7.0	18.5	1.04	.97	38	17	7
G	1st ration,	775	32	2.14	26750	5.7	16.7	7.6	17.7	.98	.94	43	17	8
	2d ration,		34	2.16	26200	5.5	16.2	5.6	15.4	.90	1.05	36	18	6
H	Wide ration,	775	35	1.42	26600	9.0	17.3	7.0	16.7	.84	1.04	42	21	8
	Nar. ration,		37	2.27	25050	4.9	17.4	5.1	17.4	.90	1.00	29	19	6
I	1st ration,	750	36	2.34	28850	5.6	23.0	8.9	17.0	1.02	1.35	52	23	9
	2d ration,		38	2.74	27950	4.5	21.7	7.6	17.4	1.10	1.25	44	20	7
Average 9 tests with wide rations,		750	–	1.68	26650	7.5	18.6	9.4	16.8	.93	1.12	56	21	10
Average 9 tests with narrower rations,		750	–	2.17	25900	5.6	18.0	7.6	16.8	.95	1.08	46	19	8
Standard suggested by the Station,‡		—	–	2.50	31000	5.6	—	—	—	—	—	–	–	–

* Total cost less value of obtainable manure.

† Assuming butter to contain 82.4 per cent. butter-fat and 96.3 per cent. of the fat in the whole milk to be saved in the butter.

‡ This is nominally for 1000 pounds live weight, but, actually, a smaller cow in full flow of milk needs more than a large cow giving less milk. It may, therefore, apply to cows no larger than some of those in the above tests.

THE EFFECT OF NARROW RATIONS ON MILK FLOW AND BUTTER YIELD.

At the time of the second test the cows were, in each case, one to four weeks further along in the period of lactation, and would, in consequence, naturally have fallen off in milk flow

and butter yield. It is impossible to say exactly how much this natural shrinkage in milk would have been. In animals as near calving as some of these were the shrinkage would have been large; while in the case of cows in "flush," the decrease would have been less marked. The shrinkage in butter yield would, of course, be less, because the milk grows richer in fat as the period of lactation advances.

From the summary of the past three winters' work it will be seen that there was an increase in milk flow in five cases (herds A, E, F, H, and I,) when the animals were fed a narrow ration, over that obtained with the wider ration, and in two other cases (herds B and C) the yields were essentially the same in both tests, although in those instances the narrow ration was fed four weeks after the wide. Of the eight herds which were fed the wide ration, followed by a narrower one, all except one (D) gave an increase in butter yield during the second test. The fact that there was more often an increase in butter yield (calculated from the butter-fat) than in the milk yield, during the period when the narrow rations were fed, would indicate an increase in the percentage of fat as a result of using the narrow rations. In some instances this was noticeably the case. In herd C, with no increase in milk flow, there is quite a little gain in butter, while in herd I the contrast is still more noticeable. No determinations were made of the percentages of the other constituents of the milk.

Although a shrinkage in production would naturally follow from advancement in period of lactation, the herds as a whole more than held their own when changed to the narrower ration from one to four weeks after the first test. The results are in accord with observation and experiment elsewhere in that so far as physiological effects are concerned narrow (nitrogenous) rations give larger yields of both milk and butter than do wide (carbonaceous) rations.

COSTS OF THE DIFFERENT RATIONS.

Omitting herd G and considering only the eight herds which were fed a narrower ration following a wider one, there are six cases where the total cost of producing 100 pounds of milk is less with the narrower ration, and six cases where the cost of one pound of butter is less. One or more nitrogenous grain

feeds, like cotton seed, gluten or linseed meals, were usually substituted in the second test for a part of the corn and wheat feeds used in the first test. The total cost of the rations and the net cost, after deducting the estimated manurial value, is shown in the summary table. In getting the net cost, the manurial value is estimated by assuming that 85 per cent. of the nitrogen, phosphoric acid and potash of the feeding stuffs are obtainable in the manure, and that they have the same value as in ordinary commercial fertilizers. The following tables give the costs of food to produce 100 pounds of milk and one pound of butter.

Cost of food to produce 100 pounds of milk.

Herd.	Year.	Total Cost of Feed.		Net Cost of Feed.*	
		Wide Ration.	Narrower Ration.	Wide Ration.	Narrower Ration.
		Dollars.	*Dollars.*	*Dollars.*	*Dollars.*
A,	1893-4	1.47	1.15	.79	.52
B,	1893-4	1.00	1.03	.53	.50
C,	1893-4	1.41	1.30	.91	.73
D,	1894-5	1.01	1.10	.50	.50
E,	1894-5	1.03	.87	.59	.39
F,	1894-5	.85	.97	.38	.38
G,	1894-5	1.05	.94	.43	.36
H,	1895-6	1.04	1.00	.42	.29
I,	1895-6	1.35	1.25	.52	.44
Average,	—	**1.13**	**1.07**	**.56**	**.46**

* Total cost less that of obtainable manure.

Cost of food to produce one pound of butter.

Herd.	Year.	Total Cost of Feed.		Net Cost of Feed.*	
		Wide Ration.	Narrower Ration.	Wide Ration.	Narrower Ration.
		Dollars.	*Dollars.*	*Dollars.*	*Dollars.*
A,	1893-4	.24	.19	.13	.09
B,	1893-4	.21	.20	.11	.10
C,	1893-4	.29	.25	.19	.14
D,	1894-5	.18	.20	.09	.09
E,	1894-5	.18	.15	.10	.07
F,	1894-5	.15	.17	.07	.07
G,	1894-5	.18	.18	.08	.06
H,	1895-6	.21	.19	.08	.06
I,	1895-6	.23	.20	.09	.07
Average,	—	**.21**	**.19**	**.10**	**.08**

* Total cost less that of obtainable manure.

SUMMARY.—THE EXPERIMENTS AND RESULTS.

In the winter of 1892–93, the Station began making systematic observations of the winter feeding practices of Connecticut dairymen. The chief points upon which information was obtained were: Number of animals in the herd; breed, age, and approximate weight of each cow; length of time since dropping last calf and till due to calve again; kinds, weights, and chemical composition of feeding stuffs used; weights of milk flow; percentages and amounts of butter-fat in the milk.

The feeding stuffs used on these farms included quite a long list, but those that tend to make a wide ration were employed in much greater proportions than were those which tend to make rations narrow. The following is a nearly complete list. The nutritive ratios are calculated from the analyses made in the experiments taken, together with other analyses of like materials, as used in New England. The more nitrogenous materials are, of course, those richest in protein or "flesh formers," while the more carbonaceous are those poorer in protein and having larger proportions of the fuel ingredients, i. e., fats, and especially the carbohydrates. The former, with smaller nutritive ratios (ratio of protein to fuel ingredients), tend to make narrow rations, while the latter make wide rations.

CLASSIFICATION OF FEEDING STUFFS USED IN THESE TESTS.

Nitrogenous Feeding Stuffs—Rich in Protein.	Nutritive Ratio.	Carbonaceous Feeding Stuffs—Poor in Protein.	Nutritive Ratio.
Cotton seed meal, - -	1.3	Corn fodder or ensilage,	8.5
Linseed meal, - -	1.8	Corn meal, - - - -	9.8
Cream gluten, - -	2.1	Corn and cob meal, -	9.9
Gluten meal, - - -	2.4	Roots (turnips, etc.), -	9.5
Malt sprouts, - -	2.5	Potatoes, - - -	13.0
Pea meal, - - -	3.2	Hay, mixed grasses, -	10.9
Gluten feed, - - -	4.0	Red-top hay, - -	10.8
Wheat bran, - - -	4.0	Timothy hay, - -	13.0
Wheat middlings, - -	4.2	Timothy and red-top hay,	11.5
Clover hay, - - -	5.1	Oat hay, - - -	11.0
Rowen hay, - - -	5.3	Corn stover, - - -	17.4

In 1892–93 sixteen herds were visited and a five-days' test was made with each. In 1893–94 six herds were visited, and in four instances the time of study of the feeding, management, and products of each herd was extended to twelve days. As soon as the analyses could be made, the amounts of actual nutrients in the rations fed were calculated, and in three cases other rations were

suggested. The feed was gradually changed to the suggested ration with these three herds, and after four weeks from the close of the first test another twelve-days' test was made with the new ration.

In 1894–95 four herds were studied on the same plan as in the longer studies made the previous winter, except that the length of time between the two tests, on the same herd, was shortened to two weeks.

In 1895–96 two herds were studied on the same plan as those of the previous winter, except that the time between tests was reduced to nine days. In one of these cases the herd was fed a very large ration of protein with an unusually narrow nutritive ratio.

RATION FOR A MILCH COW.

A proper ration for a milch cow would furnish the nutrients needed to form the materials of the body and the milk, and the energy required to do the necessary muscular work and keep the body warm. Just what weights of digestible protein, fats, and carbohydrates will, as a general average, meet these needs is a matter of uncertainty. The following rations have been suggested as guides in the practical feeding of milch cows of a live weight of 1000 pounds. It is to be remembered, however, that a small cow giving a good amount of milk may need more than a much larger cow producing less. It is worth noting that in Germany the heavier breeds of cows are more commonly and the lighter breeds—like the Jerseys—less commonly used for dairy purposes than with us. Such light-weight cows may, however, demand as much food and as much protein for large milk production as larger cows.

	German Standards.					Standard tentatively suggested by the Station.
	Wolff's Standard for 1000 lbs. live weight.	Lehmann's for a Cow Giving				
		11 lbs. Milk Daily.	16½ lbs. Milk Daily.	22 lbs. Milk Daily.	27½ lbs. Milk Daily.	
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Organic matter, - -	25.0	25.0	27.0	29.0	32.0	25.0
Digestible protein, -	2.5	1.6	2.0	2.5	3.3	2.5
Digestible fats, - -	.4	.3	.4	.5	.8	.5 to .8
Digestible carbohydrates, - - -	12.5	10.0	11.0	13.0	13.0	13 to 12
	Cal.	Cal.	Cal.	Cal.	Cal.	Cal.
Fuel value, - - -	29600	22850	25850	30950	33700	31000
Nutritive ratio, - -	1:5.4	1:6.7	1:6.0	1:5.7	1:4.5	1:5.6

The ration suggested by the Station is founded upon the standard of Wolff, with allowance for the abundance and cheapness of foods of high fuel value, i. e., those rich in carbohydrates and fats, in the United States. The experience of the last two years would, however, indicate that, in general, it is more profitable to feed a cow in "the flush" rather more protein than the suggested ration calls for. The very decided trend of these experiments is toward nitrogenous feeding for large milk production. The German standards of Lehmann, which are later than those of Wolff, give expression to the same tendency in the results of late experience and experiment in Germany.

GENERAL CONCLUSIONS.

The cost of producing milk and butter depends largely upon the kind of cows and their condition as regards time from calving. Many of the individual cows in these tests were not returning the cost of feed. One of the first things our dairymen need to do is to make a closer study of the individual animals of their herds and to reject the unprofitable ones. The relative productiveness of cows can be easily learned by the use of the Babcock test, together with the daily weighing of the milk. In these tests the cost of the ration depended largely upon the proportion of the cheaper coarse fodders like corn silage, corn stover, clover hay, oat hay, and second quality ordinary hay, which went to make up the total coarse fodders of the ration. The better grades of hay, such as timothy and red-top, were among the most expensive feeding stuffs used. When good hay sells for from fifteen to eighteen dollars per ton it is generally more profitable to sell than to feed to dairy cows.

A liberal proportion of the nitrogenous grain feeds tended to lessen the total cost of the ration in the majority of the cases, while the net cost was greatly lessened by their use. The nitrogenous (protein) feeding stuffs like clovers, cotton seed, linseed and gluten meals, should be more extensively used as dairy feeds. These feeds have been shown to exert a greater influence on the quantity and quality of animal products than corn and even wheat feeds, and when the manure is carefully saved they are of great value for keeping up the fertility of the farm.

INVESTIGATIONS ON METABOLISM IN THE HUMAN ORGANISM.

PRELIMINARY ACCOUNT OF EXPERIMENTS ON THE INCOME AND OUTGO OF THE BODY AND THE EFFECTS OF DIFFERENT DIETS.

BY W. O. ATWATER, C. D. WOODS AND F. G. BENEDICT.

In the year 1892 the first steps were taken at Wesleyan University toward the development of an apparatus for measuring the income and outgo of the animal body. It was proposed to study, among other things, the application of the law of the conservation of energy in the animal organism and plans were made for experiments with men. The investigation was undertaken jointly by Professors Atwater and Rosa, and was conducted under the patronage of the University and in connection with the Storrs Experiment Station. In the report of the Station for 1893 the purpose of the inquiry was stated in the following language:

"Research upon nutrition has brought us to the point where the study of the application of the laws of the conservation of matter and of energy in the living organism are essential. That is to say, we must be able to determine the balance of income and outgo of the body, and this balance must be expressed both in terms of matter and of energy. For this purpose a respiration calorimeter is being devised. This is an apparatus in which an animal or a man may be placed for a number of hours or days and the amounts and composition of the food and drink and inhaled air; the amounts and composition of the excreta, solid, liquid and gaseous; the potential energy of the materials taken into the body and given off from it; the quantity of heat radiated from the body; and the mechanical equivalent of the muscular work done, are all to be measured. The experimenting is complicated, costly and time-consuming. The results already obtained are, however, very encouraging in their promise of future success."

Fortunately for the success of the enterprise the interest of the trustees and officers of Wesleyan University, especially in the purely scientific phases of the inquiry, was such that laboratory rooms and appliances were made available, as

were also the services of the University mechanician, Mr. O. S. Blakeslee, and the use of the mechanical laboratory, which is especially fitted for the construction of scientific apparatus. With these facilities and a portion of the funds of the Experiment Station the work progressed so far that the success of the enterprise seemed reasonably assured. The need of much larger sums for the experimental work, however, became more and more pressing. Here again the research met with good fortune. In the year 1894 a provision was made by act of Congress for an inquiry into the food and nutrition of the people of the United States. The responsibility for the inquiry is vested in the Secretary of Agriculture, by whom it was assigned to the Office of Experiment Stations of the Department of Agriculture, and the immediate charge was placed in the hands of the Director of the Storrs Experiment Station as Special Agent of the Department. It was considered that a research not only germane, but fundamental to such an inquiry, might be appropriately aided from this fund, though the amount which could be utilized for the purpose was small. In 1895 the Legislature of Connecticut provided a special annual appropriation to be expended by the Storrs Experiment Station for food inquiries. The resources of the Station for this purpose were thus increased, and with the supplement from the General Government and the private aid referred to, it has been possible to greatly enlarge the scope of the inquiry and to prosecute the work in a manner which would otherwise have been entirely out of the question. Indeed this may be regarded as one of that class of cases in which the higher scientific research has been favored by a happy combination of private and public support in such a way as not only to insure the greatest economy in the use of money and other resources, but also to promise a valuable outcome.

The inquiry has thus assumed such form that it naturally divides itself in two parts. These have to do respectively with the metabolism of matter, and the metabolism and conservation of energy.

The purpose of the present article is to give a brief preliminary account of so much of the work thus far done as bears directly upon the metabolism of matter. The results obtained

regarding the balance of income and outgo of energy are to be held until some changes, which experience has indicated to be desirable in the apparatus and methods, can be made, and the results already obtained can be verified and new ones added.

In the devising and elaborating of the apparatus, as well as in the actual carrying out of the experimental work, Prof. E. B. Rosa of Wesleyan University has had an active share. Upon him has devolved especially the devising and care of that part of the apparatus and inquiry which has to do with its physical side, including the measurement of the heat radiated from the body. The chemical side of the inquiry, and with it the determinations of the potential energy of the products of income and outgo have been superintended by Prof. Atwater.

Besides the names of the authors of the present report those of the collaborators should be mentioned. Mr. A. W. Smith had much to do with the development of the apparatus, especially the physical side, and with the carrying out of the experiments. He was himself the subject of the last of the four experiments here described. Dr. O. F. Tower has done a large amount of the chemical work and has been otherwise associated with the experiments. He was the subject of the third experiment of the four recounted here. Mr. A. P. Bryant rendered valuable assistance in the chemical part of the inquiry. Mr. H. M. Burr had the charge of the preparation of the food for the experiments and has had a large share in the work of analysis.

It is now expected that the part of the work which bears more directly upon the conservation of energy will be published hereafter under the joint authorship of Professors Atwater and Rosa.

The following is an abbreviated description of the apparatus and methods used and of the results of four experiments upon the income and outgo of carbon and nitrogen. In each of the experiments the subject remained for several days inside the respiration chamber, the periods being from two and one-fourth to twelve days.

A more detailed report of the experiments here described has been made to the Department of Agriculture for publication in a Bulletin of the Office of Experiment Stations. The

present account is taken from that report by arrangement with the Department. Since the Bulletins of the Department are distributed among institutions and to persons interested in the details of such inquiries it will suffice here to give a condensed statement of the more important facts.

APPARATUS.

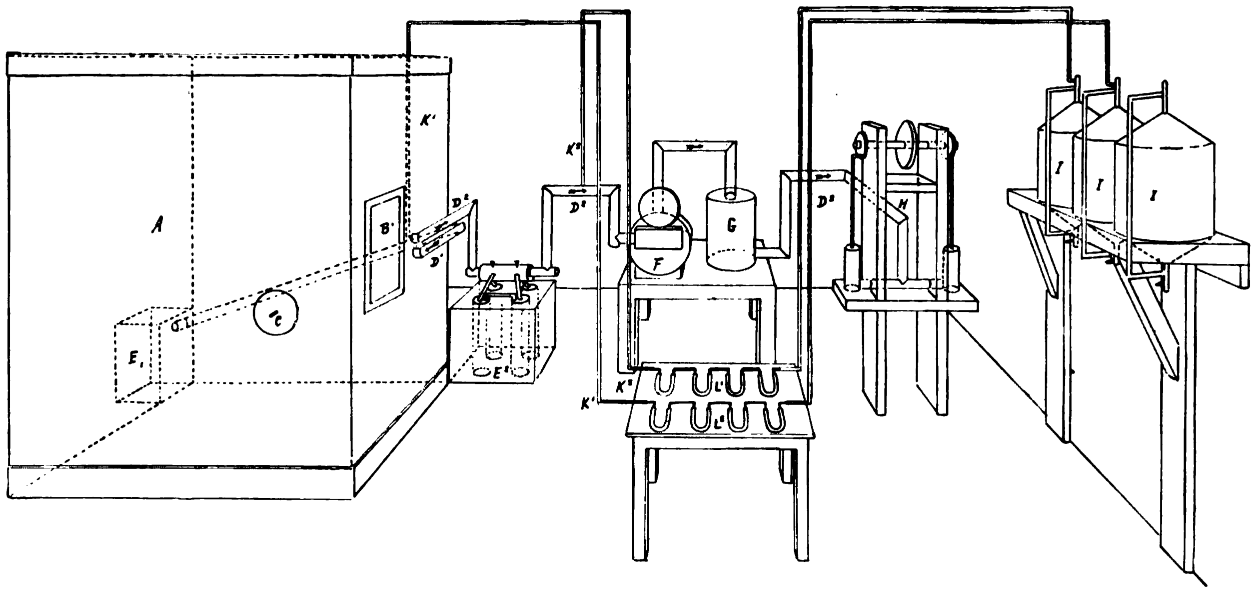
The apparatus consists essentially of a respiration chamber in which the subject stays during the experiment, and, with this, appliances for maintaining a current of air through the respiration chamber and for measuring and analyzing this ventilating current of air. There are also appliances for measuring the heat given off from the body.

The general arrangement will be made clear by the outline sketch on the opposite page. This shows the relations of the several parts, although numerous details of apparatus and machinery are omitted, and the parts are not drawn to scale nor are they shown in exactly the relative positions in which they were actually placed.

So far as concerns the experiments herewith reported, which are of the nature of the common respiration experiments, the apparatus may be considered as a modification of the well known Pettenkofer apparatus. The general principle is the same. The arrangements for maintaining the current of air and for measuring its volume and analyzing portions are, however, quite different from those which have been commonly used with the Pettenkofer apparatus.

RESPIRATION CHAMBER.

This is a room or box in which a man may live comfortably during the period of an experiment. The inside dimensions are: length, 2.15 m. (7 ft.), width, 1.22 m. (4 ft.); height, 1.92 m. (6 ft. 4 in.). It is provided with conveniences for sitting, sleeping, eating, and working, as well as arrangements for ventilation and for the study of the respiratory products. The chamber consists, in fact, of three concentric boxes, the inner one of metal and the two outer ones of wood. The inside volume is approximately 4.7 cubic meters. An opening in the front end of the metal chamber, 70 cm. high and 49 cm. wide (27½ x 19⅜ in.), serves both the purpose of a window and that of a door for entrance and exit.



OUTLINE SKETCH OF RESPIRATION APPARATUS.

A. Respiration chamber.
B. Glass door.
C. Food aperture.
D_1. Pipe for incoming air to ventilate chamber.
D_2. Pipe for outgoing air.
E_1. Refrigerating apparatus for cooling the incoming air.
E_2. Refrigerating apparatus for cooling the outgoing air.
F. Meter for measuring air current.
G. Tension equalizer for air current.
H. Air pump for drawing air through the whole apparatus.
J. J. J. Aspirators for drawing samples of air for analyses.
K_1. Tube for sample of incoming air for analyses.
K_2. Tube for sample of outgoing air for analyses.
L_1 and L_2. Absorption tubes for analyses of the samples of outgoing and incoming air.

Numerous passages through the wooden and metal walls are needed for tubes to convey the ventilating current of air; wires for various electric connections; and the aperture ("food tube") for passing the food and drink into the apparatus and taking out the solid and liquid excretory products. The tubes through which the currents of air ("ventilating tubes") pass have an internal diameter of 4 cm. (1½ in.). The food aperture is of copper and has an internal diameter of 15 cm. (6 in.). It is situated on the left side of the apparatus (see diagram) and is provided with a cap at each end. The outer cap is attached by a screw so that it may be closed air tight. In putting in the food and other materials the cap is taken off, the receptacle containing the food is placed in the tube and the cap put on again. A signal is then given to the man inside who removes the inner cap and takes out the receptacle. The materials from within are passed out in corresponding manner. In this way there is no danger of ingress or egress of any considerable quantity of air.

A wet and dry bulb hygrometer, capable of being read to hundredths of a degree centigrade is hung in the rear of the chamber and observations are made by the occupant, generally at intervals of two hours, during the period of the experiment. These observations are reported by the telephone and show the hygrometic condition of the air inside the apparatus.

The furniture used in the experiments here reported consisted of a light, folding canvas cot bed; a folding chair; and a folding table. Such clothing and bedding as were needed for comfort were taken in by the man at the beginning of the experiment and small articles were passed in and out through the food tube at convenient times. The floor was protected by carpeting. The amounts of water held by the furniture and clothing, etc., were determined as accurately as practicable by weighings at the beginning and end of each experiment.

APPARATUS FOR MEASURING AIR AND TAKING SAMPLES FOR ANALYSIS.

The essential features of a respiration experiment are the maintenance of a proper current of air, the accurate measurement of its volume and the determination of the respiratory products. The air was drawn through the apparatus by means

of specially devised air pumps, its total current was measured by a gas meter especially constructed for the purpose, the samples of incoming and outgoing air were drawn by aspirators, the carbon dioxide in the sample was determined by absorption by soda lime, and the water by absorption by sulphuric acid. The volume of air passing through the apparatus varied from 50 to 75 liters per minute. The longest experiment was of 12 days duration, and was made with an air current of approximately 55 liters per minute. It is desirable to have the incoming current of air as dry as possible. This drying was easily accomplished by surrounding a portion of the pipe through which it passed with a freezing mixture of salt and ice.

The samples of air for analysis were drawn by means of aspirators, two of which had previously served for the calibration of the meter. These aspirators, three in number, are cylinders of galvanized iron, standing upright, with conical ends. The cylinders are 56 cm. (22 in.) in diameter and 46 cm. (18 in.) in height, exclusive of cones which form the ends. To fill the aspirators the water is introduced near the top while the air passes out from the upper neck. In drawing the samples of air the water passes out from the lower while the air to be measured enters the upper neck. Horizontal tubes connect the two necks with an upright glass tube on the side of the aspirator. This serves as a gauge and shows the height of the water. It is accurately marked at the top and bottom and thus permits the drawing off of a definite quantity of water and consequently the accurate measurement of the volume. In taking a sample the aspirator is first filled to the mark indicated on the water gauge outside, the connection is then made by a 3-way cock with the tube through which the sample of air is drawn from the main current.

APPARATUS FOR DETERMINING THE CARBON DIOXIDE AND WATER IN SAMPLES OF AIR.

The constituents of the air determined in the experiments described beyond were carbon dioxide and aqueous vapor. The determinations are made by absorbents, soda lime for the former and sulphuric acid for the latter. These reagents are contained in ordinary glass U tubes. The device above referred to for removing the moisture from the main

air current by cooling to about -17° centigrade leaves a small and reasonably uniform amount of moisture and thus greatly facilitates the determination of the latter in the samples analyzed. Four U tubes are used for the absorbing, two for the carbon dioxide and two for the water of each sample. These tubes are connected in series and conveniently supported in a nearly horizontal position while the air is passing through. For weighing they are separated and hung by loops of platinum or aluminum wire in the balance.

Freezing Apparatus.—In our experience during the several years in which the apparatus and experimental methods here used have been in process of elaboration it has been found very desirable to have the air enter the respiration chamber as dry as possible. It was with this fact in view that the plan was first adopted for freezing the air as it came from outside before it entered the chamber. The freezer used for this purpose consisted practically of two large U tubes of copper. These are connected with each other and with the pipe through which flows the current of incoming air. They stand upright in a wooden box which is kept filled with a freezing mixture of salt and ice. In this way the current of air has to pass through nearly 12 ft. of copper tubing which is covered by the freezing mixture. This method of removing the excess of moisture from the air before it enters the chamber proved so satisfactory as to lead to its adoption in quantitative determinations of the moisture in the outgoing air. For this purpose, however, a somewhat more complicated freezer is necessitated by the fact that the water which it collects must be accurately weighed.

The use of ice and salt for freezing proved unsatisfactory because of the trouble of frequent renewal, the expense for material and labor, which was not inconsiderable, the difficulty of getting a satisfactory low temperature and especially the impossibility of maintaining a constant temperature. For the later experiments we have adopted the plan of immersing the freezers in a brine cooled by the expansion of ammonia gas. For a cooling apparatus we have found the so-called "Economical Ice Machine" made by the Atlantic Refrigerating Company, of Springfield, Mass., simple, easily operated, and entirely efficient for the purpose.

METHODS OF ANALYSIS.

The methods used for the analysis of the food and feces were in general those adopted by the Association of Official Agricultural Chemists. Certain deviations were introduced where necessary. The methods used for the analyses of urine were such as are commonly followed. The methods employed in the determinations of water and carbon dioxide in the incoming and outgoing air involved some special deviations from those ordinarily in use.

PREPARATION OF SAMPLES.

Meats, vegetables, and other materials containing considerable water require to be chopped or otherwise comminuted and partially dried before grinding. For comminuting meats we use an ordinary sausage grinder. The "Excelsior Meat Grinder" has proved very satisfactory for this purpose. Potatoes, when fresh, are cut in thin slices with a knife. When cooked they are simply mashed. Bread is easily sliced, broken, and pulverized sufficiently for the purpose. The samples when too moist for grinding were partially dried; the material in the original or partially dried form was sampled and ground, first in an ordinary "Excelsior Mill," afterwards in a Maercker-Dreefs Mill, by which it is easily reduced to an impalpable powder.

CARBON DIOXIDE AND WATER IN AIR.

In experiments of the class to which these belong the respiratory products commonly determined are carbon dioxide, water and volatile organic compounds.

The determination of carbon dioxide is most essential and is of course always attempted. The experience of a number of experimenters during the past twenty-five years implies that the difficulties in the way of fairly accurate results are not insuperable. The carbon dioxide given off in respiration is quickly diffused through the air and readily conveyed away by the ventilation current so that the accurate measurement of that current and determination of the percentage of carbon dioxide suffices for the ordinary purposes of experiment. If, therefore, the accurate measuring and sampling of the air are provided for, a correct method for determining the carbon dioxide in the sample is all that is needed in addition.

The accurate determination of water has been found less easy. The difficulty appears to rest not so much in the determination of moisture in the current of air as in the getting of all the moisture into the current. The water to be determined is the whole given off from the body of the subject in the respiration chamber, less the amount removed in feces and urine. Practically this means the water exhaled through the lungs and skin. For our present purpose it may be designated as water of exhalation, and taken as including the water of respiration from the lungs and that of perspiration from the skin.

While the efforts to obtain all the exhalation water in the current of air coming out of the respiration chamber were not entirely successful, not a little labor was devoted to the study of ways to determine accurately the amounts of both carbon dioxide and water in the currents. The success here was on the whole decidedly gratifying. Various reagents for absorption and methods of manipulation were tried. We finally settled upon the plan of cooling both the incoming and outgoing currents of air to remove the larger part of the water and passing samples over sulphuric acid to determine the rest. For determining the carbon dioxide we have had better success with soda lime as an absorbent than with either potassium hydroxide, solid or in solution, or barium hydroxide solution by the well known Pettenkofer method.

Determination of water.—As explained above the most of the water of both the incoming and outgoing currents of air was removed in passing through the freezers, of which there was one series of two freezers for each current. The water condensed from the incoming current was not weighed, that condensed from the outgoing current was weighed. The amount remaining in the air after it had left the freezers was determined by passing a sample over sulphuric acid in U tubes.

Absorption of carbon dioxide.—As above stated, soda lime has proven the most satisfactory reagent, but it must, however, have the proper proportions of soda lime and water to fit it for the purpose. The presence of a certain amount of moisture in the soda lime is essential to the complete absorption of the CO_2.

The tests of the accuracy of the methods thus described for determining the H_2O and CO_2 in the air from the respiration

chamber were sufficient to convince us of their reliability. Plans are made, however, for more extended tests of this kind, after the introduction of changes in the apparatus which are intended to secure more accurate measurement and sampling of the air than we were able to secure with a gas meter and aspirators.

PLAN AND METHOD OF EXPERIMENTS.

In the account of experiments here given the balance of energy is omitted for the reason already explained, and only the income and outgo of matter are considered. The difficulties in the determination of the total water of exhalation, were not entirely surmounted when the experiments were made. Hence the amount of water in the outgo and with it the hydrogen balance are omitted. As the main purpose of the experiments was to gather experience in the manipulation of the apparatus and the treatment of men in the respiration chamber the determination of other elements was not attempted. Accordingly the factors actually determined and here reported are:

Income:—Food, drink and their content of nitrogen, carbon, protein (N. x 6.25), fats (ether extract), carbohydrates (by difference), mineral matter (ash).

Outgo:—Respiratory products; carbon dioxide and its content of carbon.

Feces: nitrogen, carbon, protein (N. x 6.25), fats (ether extract), carbohydrates (by difference), mineral matters (ash).

Urine: nitrogen, carbon.

Such experiments as these, which include measurement of the income of the food and drink and of the outgo of the excretory products, including those of respiration, are commonly called respiration experiments. They necessitated, however, in each case a digestion experiment, that is to say, a comparison of the food consumed and the undigested residue which gives the amounts actually digested.

DIET, MEALS.—DAILY RATIONS.

In these experiments the effort was made to have the conditions as nearly normal as possible. To this end it was essential that—

1. The diet be such as to agree with the subject.

2. The quantities of nutrients be such as to meet the actual needs of the body under the conditions in which the subject was placed during the experiment.

Meals were eaten three times daily at regular hours, thus conforming as far as possible to ordinary custom. Drinking water was allowed at all times, the weight used, however, being carefully noted. The freedom allowed in the selection of diet materially added, we believe, to the success of the experiment, although the number of different materials, including delicacies, made the analyses quite laborious.

The entire charge of weighing and cooking the food and taking of samples for analyses was placed in the hands of one individual. Indeed, throughout the whole of our experimenting the effort has been to have the observers carefully trained and unfettered by a multiplicity of duties, and the work shaped in systematic routine, in the hope that minor errors, which are almost impossible to avoid entirely, might thus be reduced to a minimum.

COLLECTING, PRESERVING AND SAMPLING OF EXCRETORY PRODUCTS.

One desideratum in experiments of this kind is to keep the air in the chamber as free from disagreeable odors as possible. To this end the feces and urine were collected in receptacles provided for the purpose, the receptacles being closed immediately, and passed out through the food aperture after they had come into temperature equilibrium with the air in the chamber. It was found that the unpleasant odor could be almost instantly destroyed by the use of an ordinary toilet "atomizing" bottle by which minute quantities of a commercial preparation, presumably containing eucalyptol, was diffused into the air of the chamber. The feces were collected as described in the article on Digestion Experiments beyond.

The collection and preservation of the urine for analysis requires especial attention. In these experiments the bladder was emptied every morning at six o'clock. All the urine voided between that hour and the next morning at the same hour was taken as the urine for that day. Each day's urine was carefully weighed, thymol being added as a preserving agent.

DAILY ROUTINE OF THE EXPERIMENTS.

The digestion experiment which was made with each respiration experiment commenced two or three days before the latter, but both ended at the same time. On the second or third day of the digestion experiment the subject entered the respiration chamber, but, in order to insure normal conditions, the respiration experiment did not begin until six hours after he had entered. This allowed the man an opportunity for arranging his furniture, the hygrometer, thermometer, and other apparatus in the room, and permitted the establishment of the needed equilibrium of temperature and moisture content in the chamber preparatory to the respiration experiment itself.

The occupants of the chamber passed the time in such ways as were in general most agreeable under the circumstances. They observed regular hours of eating and sleeping. There was, of course, almost no opportunity for exercise. In the last experiment, however, a special arrangement was made for vigorous muscular labor in lifting and lowering a weight suspended from a pulley. Abundant opportunity was given for reading, considerable conversation was held between the occupant and the men who did the work outside, and the monotony was also relieved from time to time by visitors.

The amount of labor involved in these experiments is very considerable. The work goes on day and night. Relays for day and night work were, of course, necessary. During the day a force of five or six persons was generally employed. During the night, when the occupant of the chamber was asleep, the force was reduced to three.

A brief description of the routine of one day will perhaps help to a better understanding of the way in which the experiment is carried out. The night force of operators was relieved at seven o'clock A. M. At that time the subject was awake and ready for breakfast. The assistant, who had charge of the preparation and cooking of the food, prepared the breakfast; the chemist of the night force changed the system of U tubes for analysis of the air. The day chemist proceeded to start the passage of the air through the fresh system of tubes, and then weighed the system which had just been removed; the readings of the meter, by which the ventilating current of air was measured, and of temperature, barometric pressure, etc., were

made. The subject passed out the liquid and solid excreta. The readings of the hygrometer and thermometer inside the apparatus were taken by the subject on rising, and the observations were repeated once in two hours throughout the day. Naturally, the inquiry regarding the subject's physical condition, and any changes needed, received early attention in the morning.

Breakfast was ordinarily served at about half-past seven o'clock, dinner at about half-past twelve o'clock, and supper at six o'clock. Drinking water was given whenever desired, its weight and temperature being noted.

The freezing apparatus required repacking with ice and salt about once in two hours during the day and night; the rate of flow of water through the aspirators by which the samples of air for analysis were drawn was regulated every half-hour. The temperature of the air of the meter was recorded hourly. The freezers through which the outgoing air passed were changed once in twelve hours, and the water condensed in them was weighed. The absorption tubes for the water and carbon dioxide of the air samples were changed once in six hours, at which time the temperature of the aspirators, the temperature of the meter, and the readings of the meter and of the air pump register were recorded.

Concurrently with all of these operations the analytical work was carried on and completed as rapidly as possible.

When a respiration experiment lasts but three or four days, the prosecution of all this work is not extremely difficult, provided the force of operators is sufficiently large and well organized, but when it must be continued for twelve days, as was the case in the last experiment, the difficulty is gradually increased. When it is considered that both night and day forces, as well as the subject, are placed under quite unusual conditions, we deem ourselves especially fortunate in having been able to continue the experiment successfully for so long a period.

In this connection we take pleasure in expressing our appreciation of the courtesy of the Electric Light and Power Company of Middletown, by whom a constant supply of power was furnished, so that no one of the experiments was interrupted.

INDIVIDUAL EXPERIMENTS.

In the following accounts of the individual respiration experiments reference is made to digestion experiments. The latter were made in connection with the former, but the results are detailed in the article on digestion experiments beyond.

RESPIRATION EXPERIMENTS NOS. 1 AND 2.

The daily routine and details of the first two experiments were, from the nature of the case, much simpler than those of the later experiments. Improvements were constantly being suggested and adopted as the work progressed. The analysis of respiratory products are, we believe, sufficiently accurate to warrant their publication. However, it is only fair to state that these two experiments in particular are looked upon as decidedly preliminary. When it is considered that the experience was a new one to both the subject and to the observers, and that time was required to get the machinery in smooth running order, the tentative nature of these two experiments is apparent. The kinds and amounts of food were as follows:

Daily Menu. Respiration experiment No. 1. Digestion experiment No. 11.

The digestion experiment continued 4⅔ days, of which the respiration experiment covered 2⅓ days.

Breakfast.	Grams.	*Dinner.*	Grams.	*Supper.*	Grams.
Eggs, -	- about 100	Cooked meat,	- 121	Cheese, -	- 75
Butter, -	- 15	Butter, -	- 20	Milk, - -	- 600
Milk, - -	- 100	Milk, - -	- 300	Milk crackers,	- 100
Bread, -	- 100	Bread, -	- 150		
Sugar, -	- 20	Potatoes, -	- 150		
Coffee,	- about 300				

28⅗ grams, approximately, equal one ounce.

Daily Menu. Respiration experiment No. 2. Digestion experiment No. 12.

The digestion experiment continued 4⅔ days, of which the respiration experiment covered 2⅓ days.

Breakfast.	Grams.	*Dinner.*	Grams.	*Supper.*	Grams.
Eggs, -	- about 100	Cooked meat,	- 100	Cheese, -	- 75
Butter, -	- 15	Butter, -	- 20	Milk, - -	- 100
Milk, - -	- 100	Milk, - -	- 300	Milk crackers,	- 100
Bread, -	- 100	Bread, -	- 150	Sugar, - -	- 20
Sugar, -	- 20	Potatoes, -	- 150	Coffee, -	- about 300
Coffee, ·	- about 300				

RESPIRATION EXPERIMENT NO. 3.

In the third experiment the methods of operation had been considerably elaborated and improved upon, the force of observers enlarged, while the experience gained in the two former experiments added materially to its successful completion. The diet in the experiment was considerably more varied than in those preceding. The subject selected his own diet, and in order to avoid monotony, varied the daily menu by having canned peaches one day for dinner and supper and canned pears the next.

Daily Menu. Respiration experiment No. 3. Digestion experiment No. 13.

The digestion experiment continued 8⅓ days, of which the respiration experiment covered the last 5 days.

Breakfast.	Grams.	*Dinner.*	Grams.	*Supper.*	Grams.
Eggs, - -	113	Cooked beef, -	95	Milk, - - -	500
Butter, - -	10	Butter, - -	10	Bread, - -	125
Milk, - - -	100	Milk, - - -	60	Sugar, - -	10
Bread, - -	75	Bread, - -	75	Peaches or pears,	200
Sugar, - -	20	Sugar, - -	20		
Apples, - -	85	Potatoes, - -	130		
Tea or coffee, about	300	Peaches or pears,	150		
		Tea or coffee, about	300		

RESPIRATION EXPERIMENT NO. 4.

The last experiment is more detailed than the previous ones and the observations were more thoroughly systematized. The interest and enthusiasm of the gentleman who acted as subject added materially to the success of the experiment and permitted the collection of much more valuable data than would otherwise have been possible.

Daily Menu. Respiration experiment No. 4. Digestion experiment No. 14.

The digestion experiment continued during 16⅔ days, of which the respiration experiment covered the last 12 days.

Breakfast.	Grams.	*Dinner.*	Grams.	*Supper.*	Grams.
White bread, -	75	Cooked beef, -	96	Milk, - - -	500
Oatmeal, - -	40	White bread, -	75	Brown bread, -	250
Beans, - -	120	Mashed potatoes, -	100		
Milk, - - -	150	Butter, - - -	30		
Butter, - -	15	Apples, - -	125		
Sugar, - -	20				

The experiment continued for 12 days. It was divided into the equivalent of 4 periods of 3 days each, though actually there were 5 periods. The first was 1⅝ and the fifth, 1⅜ days, making together 3 days. The first short period was regarded as introductory. During this period, as during the fifth, the subject did not engage in any muscular or mental work except such reading and very slight physical exercise as were needed to pass away the time comfortably.

The second period, which was the first experimental period proper, was devoted to mental labor. The subject engaged for eight hours a day or thereabouts in the active work of either calculating results of previous experiments or studying a German treatise on physics. The mental application was as intense as it could well be made. The third period, which was the second experimental period, likewise of three days duration, was given to nearly absolute rest. During this time the subject was as quiet as possible, neither exercising the muscles nor working with the brain. During a larger part of the time he reclined upon the bed. Of course it was impossible to avoid all intellectual activity, but the amount was made as small as practicable. The fourth period, or third experimental period, was one of intense muscular activity. A pulley was attached to the top of the chamber. Over this passed a cord. One end of the cord was attached to a block of iron weighing 5.7 kilograms. To the other end was attached a handle. This provided for active exercise not only of the arms, but also of the legs and other parts of the body. The whole arrangement was quite similar to some of the forms of apparatus very commonly used for gymnastic exercise. With this the subject worked severely for eight hours on each of the three days so that at the end of each day's work he was thoroughly tired. He perspired very freely during the working hours. This last experimental period was followed by the final short period of rest.

In examining the detailed results of the experiments it is interesting to note that, whatever had been the occupation during the day a period of six hours' rest was sufficient to bring the elimination of carbon dioxide back to a normal quantity. Even after the large elimination of carbonic acid which accompanied each period of hard muscular work, amounting at times

to 500 grams for six hours, the simple return to rest was followed almost immediately by a return to the normal elimination of CO_2.

In the case of the elimination of nitrogen in the urine, however, the increase consequent upon hard muscular work, or the decrease when the body was in a state of rest, did not manifest itself until some hours after the muscular work began or ended. This interval, during which the excretion of nitrogen lags behind the metabolism, and which we have got in the way of calling the "nitrogen lag," may be assumed to be longer or shorter. For instance, it may be supposed that the nitrogen metabolized in a given day beginning at six in the morning will be excreted in the urine of the day beginning the following noon, thus allowing a lag of six hours. This assumption was actually made in the calculations of nitrogen balance in one of the experiments here reported. In another experiment a lag of twelve hours was allowed for. As explained in the discussion of the details of respiration experiment No. 4 beyond, thirty hours may be a more nearly correct period, and estimates are made accordingly.

We have been unable to find data for judging at all accurately as to the length of this interval of lag. For that matter it is doubtless impossible to make any accurate estimate, for there is no assurance that either exactly the same nitrogen or the same amount of nitrogen that is metabolized during a given period will be contained in the urine of any other period of equal length unless both periods are very long. Sufficient evidence of this is found in the fluctuations in the daily nitrogen excretion in the experiments herewith reported, when the diet and other conditions were reasonably uniform.

RESULTS OF THE RESPIRATION EXPERIMENTS.

The detailed results of these experiments are given in the Bulletin of the Department of Agriculture above referred to, in which the methods of calculating the results from the numerous data are more or less fully explained. It will, therefore, suffice here to briefly recapitulate the principal data. Those for ventilation and CO_2 exhalation are epitomized in table 9 beyond. Those for nitrogen and carbon balance are summarized in tables 7 and 8 herewith.

TABLE 7.

Nitrogen balance and estimated gain and loss of protein in respiration experiments.

The figures of column C are obtained by subtracting those in B from those in A. In like manner E = A — (B + D) or E = C — D.

DATE.	NITROGEN. A In Food.	B In Feces.	C Digested.	D In Urine.	E Stored (+) or Lost (—).	Estimated Gain (+) or Loss (—) of Protein.*	Corresp'd'g Gain (+) or Loss (—) of Nitrogenous Tissue.†
	Grams.	Grams	Grams.	Grams.	Grams.	Grams.	Grams.
Experiment No. 1. (*E. O.*)							
Feb. 17–18,	22.7	.9	21.8	20.2	+1.6	+10.0	+43.3
Feb. 18–19,	22.7	.9	21.8	19.0	+2.8	+17.5	+75.8
Feb. 19 (¼ day),	10.1	.3	9.8	3.8	+6.0	+37.5	+162.5
Total, 2¼ days,	55.5	2.1	53.4	43.0	+10.4	+65.0	+281.6
Experiment No. 2. (*E. O.*)							
Feb. 26–27,	19.2	1.6	17.6	18.6	—1.0	—6.3	—27.3
Feb. 27–28,	19.2	1.6	17.6	17.5	+0.1	+0.6	+2.6
Feb. 28 (¼ day),	4.5	.5	4.0	3.6	+0.4	+2.5	+10.8
Total, 2¼ days,	42.9	3.7	39.2	39.7	—0.5	—3.2	—13.9
Experiment No. 3. (*O. F. T.*)							
Mch. 16–17,	16.1	.9	15.2	12.7	+2.5	+15.6	+67.6
Mch. 17–18,	16.1	.9	15.2	13.5	+1.7	+10.6	+45.9
Mch. 18–19,	16.1	.9	15.2	13.6	+1.6	+10.0	+43.3
Mch. 19–20,	16.1	.9	15.2	13.7	+1.5	+9.4	+40.7
Mch. 20–21,	16.1	.9	15.2	15.2	0.0	0.0	0.0
Total, 5 days,	80.5	4.5	76.0	68.7	+7.3	+45.6	+197.5
Experiment No. 4. (*A. W. S.*)							
Mch. 23 (⅝ day),	5.0	.9	4.1	9.1	—5.0	—31.3	—135.6
Mch. 24–25,	16.2	1.4	14.8	14.1	+0.7	+4.4	+19.1
Mch. 25–26,	16.2	1.4	14.8	13.1	+1.7	+10.6	+45.9
Mch. 26–27,	16.2	1.4	14.8	13.7	+1.1	+6.7	+29.0
Mch. 27–28,	16.2	1.4	14.8	12.6	+2.2	+13.7	+59.4
Mch. 28-29,	16.2	1.4	14.8	11.9	+2.9	+18.1	+78.4
Mch. 29-30,	16.2	1.4	14.8	12.4	+2.4	+15.0	+65.0
Mch. 30–31,	16.2	1.4	14.8	13.1	+1.7	+10.6	+45.9
Mch. 31–Apr. 1,	16.2	1.4	14.8	11.7	+3.1	+19.4	+84.1
Apr. 1–2,	16.2	1.4	14.8	16.4	—1.6	—10.0	—43.3
Apr. 2–3,	16.2	1.4	14.8	14.3	+0.5	+3.1	+13.4
Apr. 3–4,	16.2	1.4	14.8	16.1	—1.3	—8.1	—35.1
Apr. 4 (⅜ day),	11.2	.5	10.7	5.3	+5.4	+33.7	+146.0
Total, 12 days,	194.4	16.8	177.6	163.8	+13.8	+85.9	+372.2

* N. multiplied by 6¼. † Assumed to be equivalent to protein multiplied by 4⅓.

TABLE 8.

Carbon balance and estimated gain and loss of fats in respiration experiments.

The figures of column E are obtained by subtracting those in B from those in A. In like manner F = A − (B + C + D) or F = E − (C + D).

Date.	Carbon.								Estimated Gain (+) or Loss (−) of Fat.
	A	B	C	D	E	F	G	H	
	Total Income Food.	Total Outgo in Feces.	Total Outgo in Urine.	Total Outgo in CO_2.	Total Digested.	Gained (+) or Lost (−).	In Protein. Stored (+) or Lost (−).	In Fat. Stored (+) or Lost (−).	
Experiment No. 1. (E. O.)	Grams.	Grms.	Grms.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Feb. 17–18, -	289.3	9.0	11.7	216.5	280.3	+52.1	+5.3	+46.8	+61.2
Feb. 18–19, -	289.3	9.0	11.0	211.7	280.3	+58.6	+9.3	+48.3	+63.1
Feb. 19 (¼ day),	111.0	3.0	2.2	49.5	108.0	+56.3	+19.9	+36.4	+47.6
Total, 2¼ days,	689.6	21.0	24.9	477.7	668.6	+167.0	+34.5	+131.5	+171.9
Experiment No. 2. (E. O.)									
Feb. 26–27, -	260.6	9.9	14.7	233.5	250.7	+2.5	−3.3	+5.8	+7.6
Feb. 27–28, -	260.6	9.9	13.9	207.3	250.7	+29.5	+.3	+29.2	+38.2
Feb. 28 (¼ day),	67.1	3.3	2.9	46.8	63.8	+14.1	+1.3	+12.8	+16.7
Total, 2¼ days,	588.3	23.1	31.5	487.6	565.2	+46.1	−1.7	+47.8	+62.5
Experiment No. 3. (O. F. T.)									
Mch. 16–17, -	239.5	6.9	8.7	220.9	232.6	+3.0	+8.3	−5.3	−6.9
Mch. 17–18, -	239.5	6.9	9.9	215.3	232.6	+7.4	+5.6	+1.8	+2.4
Mch. 18–19, -	239.5	6.9	10.6	218.8	232.6	+3.2	+5.3	−2.1	−2.7
Mch. 19–20, -	239.5	6.9	11.8	222.9	232.6	−2.1	+5.0	−7.1	−9.3
Mch. 20–21, -	239.5	6.9	13.6	221.7	232.6	−2.7	0.0	−2.7	−3.5
Total, 5 days,	1197.5	34.5	54.6	1099.6	1163.0	+8.8	+24.2	−15.4	−20.0
Experiment No. 4. (A. W. S.)									
Mch. 23 (⅝ day),	86.4	6.6	5.9	139.2	79.8	−65.3	−16.6	−48.7	−63.7
Mch. 24–25, -	244.1	10.5	7.6	237.0	233.6	−11.0	+2.3	−13.3	−17.4
Mch. 25–26, -	244.1	10.5	5.9	244.3	233.6	−16.6	+5.6	−22.2	−29.0
Mch. 26–27, -	244.1	10.5	8.9	231.5	233.6	−6.8	+3.6	−10.4	−13.6
Mch. 27–28, -	244.1	10.5	11.5	220.7	233.6	+1.4	+7.3	−5.9	−7.7
Mch. 28–29, -	244.1	10.5	13.0	240.6	233.6	−20.0	+9.6	−29.6	−38.7
Mch. 29–30, -	244.1	10.5	8.4	229.4	233.6	−4.2	+8.0	−12.2	−16.0
Mch. 30–31, -	244.1	10.5	10.8	243.2	233.6	−20.4	+5.6	−26.0	−34.0
Mch. 31–Apr. 1,	244.1	10.5	8.7	348.0	233.6	−123.1	+10.3	−133.4	−174.4
Apr. 1–2, - -	244.1	10.5	11.0	384.7	233.6	−162.1	−5.3	−156.8	−205.0
Apr. 2–3, - -	244.1	10.5	10.4	381.7	233.6	−158.5	+1.6	−160.1	−209.3
Apr. 3–4, - -	244.1	10.5	11.2	242.7	233.6	−20.3	−4.3	−16.0	−20.9
Apr. 4 (⅜ day,)	157.7	3.9	6.0	93.9	153.8	+53.9	+17.9	+36.0	+47.1
Total, 12 days,	2929.2	126.0	119.3	3236.9	2803.2	−553.0	+45.6	−598.6	−782.6

The methods for calculating the results from the observed data, which were found by weighings, measurements, and analyses—and are quite extensive—are explained in the publication just referred to. The estimates of income and outgo and gain or loss of protein are made by multiplying the nitrogen by the factor 6.25. The corresponding estimates for fats are made by assuming the protein to contain 53 per cent. and the fats, 76.5 per cent. of carbon. The carbon in the protein gained by the body is added to, or that in the protein lost is subtracted from, the carbon of the outgo; the resulting amount is subtracted from the total carbon of the income, and the difference, divided by .765, is taken as representing the gain or loss of fat. The estimates of potential energy are based upon direct determinations of the heats of combustion of food, feces and urine. In the estimates in which fat gained or lost by the body are involved, however, each gram of fat is assumed to contain 9.4 calories of potential energy. In the corresponding estimates of fuel value of the protein gained or lost it is assumed that incompletely oxidized nitrogenous compounds excreted in the urine will have the fuel value of the urea corresponding to the nitrogen of the protein.

DISCUSSION OF RESULTS.

VENTILATION AND PRODUCTION OF CARBON DIOXIDE.

The observations regarding ventilation and the effects of the presence of carbonic acid in large quantities are of decided interest.

The results are epitomized in table 9, from which it will be seen that the quantity of CO_2 in the incoming air, which was ordinary, fresh air from the outside of the building, was normal, ranging from .55 to .60 milligrams per liter. The ventilation in experiments 1 and 2, taken collectively, was at the rate of about 50 liters of air per minute; the CO_2 in the outgoing air varied from 8.0 to 12.7, and averaged 10.7 milligrams per liter. In experiment No. 3, with an average ventilation of 75 liters of air per minute, the range of CO_2 in the air was from 4.6 to 9.9 mg. per liter and the average 7.4 mg. per liter. The smaller quantity of CO_2 in the air as compared with experiments 1 and 2 was due to the larger ventilation, since the average weight of CO_2 given off in 24 hours was 806.4 grams

as compared to 778.6 grams in experiment 1 and 794.6 in experiment 2. In these three experiments the subject was either at rest or engaged in light mental work as reading.

TABLE 9.

Ventilation and CO_2 exhalation in four respiration experiments. Quantities of air supplied in the ventilating current and of carbon dioxide exhaled.

The CO_2 in the incoming air ranged from .55 to .60 milligrams per liter.

Rsp. Ex. No.	Subjects and Experimental Periods.	Ventilation. Air per Minute.	CO_2 in Outgoing Air. Amounts per Liter. Min.	Max.	Avg.	Avg. Wt. CO_2 given off in 24 hours.
		Liters.	Mgms.	Mgms.	Mgms.	Grams.
1	E. O., at rest, 2¼ days,	49	8.0	12.5	11.0	778.6
2	E. O., at rest, 2¼ days,	50	8.1	12.7	10.4	794.6
3	O. F. T., at light mental work, 5 days,	75	4.6	9.9	7.4	806.4
4	A. W. S. 1st period, at rest, 1⅝ days,	55	8.1	12.8	10.3	848.9
	A. W. S. 2d period, at mental work, 3 days,	55	8.7	12.8	10.5	851.5
	A. W. S. 3d period, at rest, 3 days,	55	9.0	12.5	10.9	871.4
	A. W. S. 4th period, at muscular w'k, 3 days,	55	9.9	24.6	16.8	1362.3
	A. W. S. 5th period, at rest, 1⅜ days,	55	10.9	13.4	11.7	897.7
	A. W. S. Total, 12 days,	55	8.1	24.6	12.3	989.2

Experiment No. 4 is of much more interest in this connection, since the differences in mental and physical exercise were much wider. During the first and fifth periods of 1⅝ and 1⅜ days, respectively, the subject was at rest. During the second period, which lasted 3 days, he was engaged in rather severe mental work. The third period was one of as nearly absolute rest as was practicable; in the fourth the subject was engaged in severe muscular work for 8 hours per day. The rate of ventilation was 55 liters per minute. The temperature of the air in the chamber was generally from 19°–20° centigrade, though it fell at times to 17° and rose during the periods of hard muscular work to 22°.

The weight of CO_2 given off in twenty-four hours ranged from about 850 to 900 grams for the days at rest, and was no larger with mental work, but averaged over 1,360 grams for the days of muscular work. During two periods of six hours each of hard muscular work the elimination of CO_2 reached 513 and 501 grams respectively. During the night or sleeping period the exhalation of CO_2 was singularly constant irrespective of the day's occupation. It amounted to 175 grams in six hours, with but slight variation from that figure.

The weight of CO_2 in outgoing air during the periods of rest and mental work ranged from 8.1–13.4 mg. per liter, but averaged not far from 11 mg. per liter. During the period of muscular work, however, the range was from 9.9 mg. per liter in the hours of rest, *e. g.*, at night, to 24.6 mg. per liter in the hours of severe work.

Authorities on ventilation commonly estimate the maximum of carbon dioxide permissible in the air of inhabited rooms at one part per thousand by volume, which corresponds to 1 cc. or about 1.97 mg. CO_2 per liter. It will be observed that the amounts of CO_2 in the air in the respiration chamber during these experiments was from 8–25 mg. per liter, and averaged 10–12 mg. per liter. In other words, the subjects of these experiments lived constantly in an atmosphere containing from five to six times the amount of CO_2 in the standard just referred to. In experiment No. 4 the CO_2 rose to nearly thirteen times the amount in the standard. The interesting fact in this connection is that no one of the subjects appeared to experience any inconvenience whatever from either this large amount of carbon dioxide or from any other products of exhalation. In experiment No. 2 the subject was for a time somewhat ill, but, apparently, the reason for this was entirely separate from the ventilation.

The subject who remained in the apparatus during the five days of the third experiment was as comfortable in every way, according to his repeated statements both during the experiment and afterwards, as if he had been breathing the air of an ordinary well-ventilated room. Even in the fourth experiment the subject was not aware of the least inconvenience or sense of discomfort during the twelve days of his sojourn in the chamber.

It may be added that these results are in accord with the late experiments by Messrs. Billings, Mitchell, and Bergey,* which imply that the discomfort experienced in poorly ventilated rooms is not due to the excess of carbon dioxide.

We venture the suggestion, however, that one cause of the discomfort felt in ill-ventilated rooms occupied by a number of

* The Composition of Expired Air and its Effects upon Animal Life. By J. S. Billings, M. D.; S. Weir Mitchell, M. D.; and D. H. Bergey, M. D. City of Washington. Published by the Smithsonian Institution, 1895. From Smithsonian Contributions to Knowledge, vol. xxix. (No. 989. Hodgkins Fund.)

people may be the large amount of moisture which accumulates in the air while at the same time the temperature rises. Some of the observations made in the experiments above described accord with this hypothesis.

NUTRIENTS AND ENERGY.

The nutrients and potential energy of the food eaten and of that digested in the four experiments are summarized in tables 10 and 12. Table 11 shows the balance of nitrogen and of carbon.

In the first experiment the diet was high in protein. The subject, a laboratory janitor, was accustomed to somewhat active muscular work and had a very hearty appetite. The diet was of his own selection and proved more than sufficient for the needs of his organism during the experiment when he was comparatively inactive. His organism stored both protein and fat.

In the next experiment, which was made with the same person, the diet was the same in kind but less in quantity. The ration proved insufficient to maintain the nitrogen equilibrium, although some fat was stored. In this case, however, the quantity of protein lost and of fat gained were quite small, so that the organism was very nearly in equilibrium, especially as regards nitrogen.

TABLE 10.

Nutrients in the four respiration experiments. Total and digestible nutrients in daily food with corresponding potential energy and average daily gain or loss of body protein and fat.

Resp. Expt. No.	Subject and Length of Experiment.	Nutrients and Energy in Daily Food. Total. Protein.	Total. Fat.	Total. Carbohydrates.	Total. Potential Energy Determined.	Digested. Protein.	Digested. Fat.	Digested. Carbohydrates.	Digested. Potential Energy Determined.	Gain (+) or Loss (—) in Body per Day. Protein.	Gain (+) or Loss (—) in Body per Day. Fat.
		Gr.	Gr.	Gr.	Cal.	Gr.	Gr.	Gr.	Cal.	Gr.	Gr.
1	E. O., 2¼ days, -	143	126	296	3230	136	123	290	2960	+14	+62
2	E. O., 2¼ days, -	121	112	281	2925	110	109	277	2645	— 3	+23
3	O. F. T., 5 days,	103	78	338	2725	95	74	331	2530	+ 9	— 4
4	A. W. S., 12 days,	101	65	329	2740	93	82	321	2500	+ 8	—66

TABLE 11.

Nitrogen and carbon balance in four respiration experiments. Average daily income and outgo and gain or loss of nitrogen and carbon in the body.

Resp. Ex. No.	Subjects and Experimental Periods.	In Digested Nutrients of Food. N.	In Digested Nutrients of Food. C.	In Material Consumed in the Body. N.[1]	In Material Consumed in the Body. C.[2]	Gain (+) or Loss (—) in the Body. N.	Gain (+) or Loss (—) in the Body. C.
		Gr.	Gr.	Gr.	Gr.	Gr.	Gr.
1	E. O., 2¼ days, no work,	21.8	280.3	19.6	225.5	+2.2	+ 54.8
2	E. O., 2¼ days, no work,	17.6	250.7	18.0	234.7	—0.4	+ 16.0
3	O. F. T., 5 days, light mental work,	15.2	232.6	13.7	230.9	+1.5	+ 1.7
4	A. W. S. 1st period, rest, 1⅝ days,	14.8	233.6	14.1	238.5	+0.6	— 4.9
	A. W. S. 2d period, mental work, 3 days,	14.8	233.6	13.1	241.0	+1.7	— 7.4
	A. W. S. 3d period, rest, 3 days,	14.8	233.6	12.5	248.4	+2.3	— 14.8
	A. W. S. 4th period, muscular w'k, 3 days,	14.8	233.6	14.1	381.5	+0.7	—147.9
	A. W. S. 5th period, rest, 1⅜ days,	14.8	233.6	15.2	260.2	—0.4	— 26.6
	A. W. S. Whole experiment, 12 days,	14.8	233.6	13.6	279.7	+1.2	— 46.1

[1] Total nitrogen of urine.

[2] Carbon of CO_2 exhaled plus that of urine.

TABLE 12.

Protein and energy in four respiration experiments. Comparison of protein and potential energy of the digested nutrients of the food with the protein and potential energy of the materials consumed and of the materials gained and lost in the body. Average quantities per day.

Resp. Ex. No.	Subjects and Experimental Periods.	In Digestible Nutrients of Food. Protein.	In Digestible Nutrients of Food. Energy.	In Material Consumed in the Body. Protein.	In Material Consumed in the Body. Energy.	In Material Gained (+) or Lost (—) in the Body. Protein.	In Material Gained (+) or Lost (—) in the Body. Energy.
		Gr.	Cal.	Gr.	Cal.	Gr.	Cal.
1	E. O., 2¼ days, no work,	136	2960	122	2310	+14	+ 650
2	E. O., 2¼ days, no work,	110	2645	113	2440	— 3	+ 205
3	O. F. T., 5 days, light mental work,	95	2530	86	2530	+ 9	0
4	A. W. S. 1st period, rest, 1⅝ days,	93	2520	89	2585	+ 4	— 65
	A. W. S. 2d period, mental work, 3 days,	93	2510	82	2615	+11	— 105
	A. W. S. 3d period, rest, 3 days,	93	2485	78	2695	+15	— 210
	A. W. S. 4th period, muscular w'k, 3 days,	93	2500	88	4325	+ 5	—1825
	A. W. S. 5th period, rest, 1⅜ days,	93	2520	95	2840	— 2	— 320
	A. W. S. Whole experiment, 12 days,	93	2500	85	3080	+ 8	— 580

In the third experiment the diet was considerably smaller in protein and energy than in the two preceding. The subject, a chemist, was accustomed to rather less muscular labor than the person in the first experiment. He was also rather lighter in weight and the diet which he chose was smaller in both nutrients and energy. There was a slight gain of protein and loss of fat during the experiment, but on the whole the organism was very nearly in equilibrium in respect to both nitrogen and carbon. The fuel value of the material actually consumed in the body was larger than either of the two preceding experiments, though somewhat smaller than that in the fourth experiment under similar conditions.

In the fourth experiment the subject was a physicist. He was taller than the subject of the third and heavier than either of the subjects in the preceding experiments. The diet, which was of his own selection, as in the previous cases, was the smallest of all in protein, though it was very nearly the same in energy as that of the third experiment. Nevertheless, the figures indicate a slight gain rather than loss of protein during all of the periods of the experiment when there was no especially large muscular activity, though there was constant loss of fat from the organism. In the period of muscular activity the loss of fat was very much larger, and there was apparently a slight loss rather than gain of protein in the organism as shown in tables 13 and 14, where allowance is made for a lag of 30 hours in the urine. The loss of carbon during the hard muscular work amounted to 148 grams per day.

It has been stated above (p. 102), that in experiment No. 4 six hours was allowed for the lag of the urine. That this time was insufficient was also pointed out, and 30 hours was suggested as the more probable period of lag. Tables 13 and 14 give the nitrogen and carbon balance in this experiment, together with the calculated protein and energy, allowing for both 6 hours' lag and 30 hours' lag. It will be seen that the results are much more uniform under the latter supposition than under the former. Thus when we allow 6 hours' lag the protein consumed during the three periods of mental work, rest, and muscular work are 82, 78, and 88 grams per day, respectively, while with a 30 hours' lag the corresponding values would be 79, 78, and 98 grams.

Table 13 shows the average daily income and outgo and gain or loss for each period. The estimates for nitrogen are on the basis of six hours and of thirty hours' lag in urine.

Table 14 shows comparison of protein and potential energy of the digested nutrients of the food with the protein and energy of the materials consumed and of the materials gained or lost from the body. The average quantities are those per day for each period. The estimates for nitrogen are on the basis of six hours' and of thirty hours' lag in the urine.

TABLE 13.

Nitrogen and carbon balance in experiment No. 4.

Periods of Three Days Each.	In Digested Nutrients of Food.		In Material Consumed in the Body.		Gain (+) or Loss (−) in the Body.	
	N.	C.	N.	C.	N.	C.
Allowing 6 hours' lag.	Grams	Grams.	Grams	Grams.	Grams.	Grams.
Hard mental work,	14.8	233.6	13.1	241.0	+1.7	− 7.4
Rest,	14.8	233.6	12.5	248.4	+2.3	− 14.8
Hard muscular work,	14.8	233.6	14.1	381.5	+ .7	−147.9
Allowing 30 hours' lag.						
Hard mental work,	14.8	233.6	12.7	241.0	+2.1	− 7.4
Rest,	14.8	233.6	12.4	248.4	+2.4	− 14.8
Hard muscular work,	14.8	233.6	15.6	381.5	− .8	−147.9

TABLE 14.

Balance of protein and energy in experiment No. 4.

Periods of Three Days.	In Digested Nutrients of Food.		In Material Consumed in the Body.		Gain (+) or Loss (−) in the Body.	
	Protein.	Energy.	Protein.	Energy.	Protein.	Energy.
Allowing 6 hours' lag.	Gr.	Cal.	Gr.	Cal.	Gr.	Cal.
Hard mental work,	93	2510	82	2615	+11	− 105
Rest,	93	2485	78	2695	+15	− 210
Hard muscular work,	93	2500	88	4325	+ 5	−1825
Allowing 30 hours' lag.						
Hard mental work,	93	2480	79	2595	+14	− 115
Rest,	93	2505	78	2715	+15	− 210
Hard muscular work,	93	2515	98	4325	− 5	−1810

THE MATERIALS AND ENERGY ACTUALLY CONSUMED AND THOSE GAINED OR LOST BY THE BODY.

In the discussion and tables above, the distinction has been made between the quantities of nutrients in the total food, those in the food digested and those actually consumed. Where the organism is in equilibrium, and there is neither gain nor loss of material, the quantities digested and those consumed would be the same. When, however, there is a gain of protein or fat the quantity consumed is less than that digested. On the other hand a loss of protein or fat corresponds to a consumption in excess of the amounts digested from the food. The tables give the quantities of energy corresponding to the nutrients consumed, as well as those eaten and digested. From these data tables 15 and 16 are drawn up with the purpose of indicating more clearly the comparison of protein and energy in the nutrients digested and in the material actually consumed in the body, together with a gain or loss of protein and energy. It is interesting to note the differences in the different experiments with the three persons who were the subjects. The differences in the persons as to weight, ordinary occupation and diet have been already referred to. It will, however, be of interest to add that some studies had been previously made which throw a little more light upon the dietary habits of two of them.

Two dietary studies were made in the family of the laboratory janitor, one in November and the other in March.* In these the average protein in the food eaten per man per day was estimated at 126 grams, and the total energy of the nutrients at 3,900 calories. The corresponding amounts digested were estimated at approximately 116 grams of protein and 3,660 calories. This was, on the whole, a liberal diet. It is slightly larger than the standard tentatively proposed by Prof. Atwater for an ordinary man at moderately hard muscular work.

Two dietary studies were made by the subject of experiment 4 at his home in a country town in another State on the occasion of vacation visits, one in the winter and the other in summer.† There was but little difference between the results of the two, and it may be supposed that they represent the dietary habits which this gentleman had naturally acquired. The averages per man per day were, approximately, for the

* Page 117, beyond; dietaries Nos. 15 and 19. † *Ibid*, Nos. 27 and 174.

total food eaten, 79 grams of protein and 3,125 calories of energy. These quantities are estimated to correspond to about 71 grams of protein and 2,955 calories of energy in the food actually digested.

These observations, taken in connection with the differences of occupation, are of interest in comparison with the figures of the tables above. In tables 15 and 16 the results are put together in such form as to bring out more clearly the comparisons between the quantities of nutrients and energy in the food, the quantities actually consumed by the body, and the gain or loss by the body in each case. The figures for experiment 4 are computed on the basis of 30 hours' lag in the urine.

It will be observed that the laboratory janitor, who was accustomed to moderately active muscular work, ten hours per day, and who was what would be called a "hearty eater," consumed during the first experiment 122 grams of the 136 grams of digestible protein in his food, and at the same time stored the remaining 14 grams according to the calculations of these experiments. Of the 2,960 calories in the food digested he consumed material corresponding to 2,310 calories. The digested nutrients of the food furnished an excess of carbohydrates and fats as well as protein, so that his organism stored fat and protein corresponding to 650 calories of energy. In the second experiment his diet was reduced so as to supply only 110 grams of digestible protein and 2,645 calories of energy. In this case his organism was estimated to consume 113 grams of protein, a trifle more than the food supplied, and 2,440 calories of energy. The organism gained considerable fat, enough to make a gain of material corresponding to 205 calories of energy.

The subjects of experiments 3 and 4, who were accustomed to only light muscular activity as is natural with their professional work, chose for their diet materials computed to supply 95 and 93 grams of digestible protein and other digestible nutrients sufficient to furnish about 2,500 calories of energy per day. When at rest in the respiration apparatus or engaged in either light or severe mental work, they consumed from 79 to 86 grams of protein and from about 2,500 to 2,700 calories of energy. This consumption must have been reasonably economical, since the amounts of nutrients available were so small.

TABLE 15.

Recapitulation of amounts of protein and energy consumed daily in each of the four respiration experiments.

Resp. Expt. No.	Subjects and Occupation.	Number of Days.	In Digested Nutrients of Food. Protein.	In Digested Nutrients of Food. Energy.	In Materials Consumed in the Body. Protein.	In Materials Consumed in the Body. Energy.	Gain (+) or Loss (—) in the Body. Protein.	Gain (+) or Loss (—) in the Body. Energy.
			Gr.	Cal.	Gr.	Cal.	Gr.	Cal.
	E. O., laboratory janitor. Weight, 148 lbs. Accustomed to moderately active exercise, and to liberal diet with considerable protein.							
1	1st experiment, larger ration,	2¼	136	2960	122	2310	+14	+ 650
2	2d experiment, smaller ration,	2¼	110	2645	113	2440	— 3	+ 205
3	O. F. T., chemist. Weight, 140 lbs. Accustomed to light muscular activity and moderate diet.	5	95	2530	86	2530	+ 9	0
4	A. W. S., physicist. Weight, 168 lbs. Accustomed to light muscular activity, and to diet with relatively small proportion of protein.							
	Severe mental work, - -	3	93	2480	79	2595	+14	— 115
	Absolute rest, - - -	3	93	2505	78	2715	+15	— 210
	Severe muscular work, - -	3	93	2515	98	4325	— 5	—1810
	Whole experiment, - -	12	93	2500	85	3080	+ 8	— 580

TABLE 16.

Comparison of materials and energy of digested food with those gained and lost by the body.

Resp. Expt. No.	Subjects and Occupation.	Number of Days.	In Digestible Nutrients of Daily Food. Protein.	Fat.	Carbohydrates.	Energy.	Gain (+) or Loss (—) in Body per Day. Protein.	Fat.	Energy.
			Gr.	Gr.	Gr.	Cal.	Gr.	Gr.	Cal.
1	E. O., no work, - -	2¼	136	123	290	2960	+14	+ 62	+ 650
2	E. O., no work, - -	2¼	110	109	277	2645	— 3	+ 23	+ 205
3	O. F. T., light mental work,	5	95	74	331	2530	+ 9	— 4	0
4	A. W. S. 1st period, rest, - -	1⅝	93	82	321	2500	+ 4	— 9	— 65
	2d period, mental work,	3	93	82	321	2500	+11	— 17	— 105
	3d period, absolute rest,	3	93	82	321	2500	+15	— 30	— 210
	4th period, muscular w'k,	3	93	82	321	2500	+ 5	—196	—1825
	5th period, rest, - -	1⅜	93	82	321	2500	— 2	— 33	— 320
	Whole experiment, -	12	93	82	321	2500	+ 8	— 66	— 580

The food in experiment 3 supplied only a trifle more protein and no more energy than was consumed, while in experiment 4, when the subject was at rest or engaged in mental work, there was, with a slight, apparent gain of protein, a decided loss of fat. That the subject of experiment 4, although a man of larger frame and larger weight than the one of experiment 3, consumed less protein, seems to accord with his habit of using small quantities of protein which is implied in the dietary studies mentioned above. But while his organism consumed smaller quantities of protein it consumed more fat and more energy than was the case with the subject of experiment 3. When the same person engaged in severe muscular work the consumption of protein rose from 78 to 98 grams per day. The consumption of energy at the same time rose from 2,715 to 4,325 calories. That there should be such an increase in the consumption of both protein and energy with the severe muscular work is not at all surprising. How the consumption of protein during the period of muscular work would have been affected if the quantity of carbohydrates and fats had been sufficient, is of course uncertain.

IN CONCLUSION.

The experiments above described offer considerable material for discussion. Since, however, they are of a preliminary character, and are to be followed by others in which the results of the experience here obtained will be used, it is deemed best to reserve the discussion until at least some of the anticipated work shall have been accomplished. Meanwhile the following statements are perhaps in place:

1. The experience here obtained emphasizes the desirability of longer experimental periods than have been customary in experiments of this class. Although a considerable number of respiration experiments have been made elsewhere with animals and man, the periods have rarely exceeded 24 hours. The results here obtained are sufficient to show that the results obtained in periods so short are less conclusive than is to be desired.

2. Much care needs to be bestowed upon the analyses of the materials of income and outgo. In the majority of experiments elsewhere reported the composition of food and solid and liquid excretory products has been in large part assumed rather than estimated from direct analyses of specimens of the

materials belonging to the experiments. In like manner there is need of the greatest possible care and accuracy in the determination of the gaseous excretory products. Nor can any of the organic matters given off in perspiration and exhalation be left out of account if the fullest accuracy is to be attained.

3. It is to be hoped that future experience may lead to such improvements as shall insure the accurate measurement of all the chemical elements involved in the income and outgo. It is evident that there are no insurmountable obstacles in the way of reasonably accurate estimation of the income and outgo of nitrogen and carbon. As regards the hydrogen the difficulties of determination have thus far been more serious, but they do not appear to be by any means insurmountable. The quantities of sulphur and phosphorus are so small that extreme accuracy is needed for their estimation in order to insure satisfactory comparison of income and outgo. The experience in this laboratory leads us, however, to hope that by refinement of methods and care in manipulation reasonably reliable results may be obtained.

4. The prospects for obtaining a satisfactory balance of income and outgo of energy are on the whole decidedly encouraging. The determination of heats of combustion by the bomb calorimeter are eminently satisfactory and there seems to be good ground to hope that ultimately the measurements of heat given off from the body may also prove feasible within the limits needed for such purposes. Satisfactory results have already been reported by other experimenters with small animals, and indeed with men during experiments of short duration.

5. The results of these experiments and of similar investigations elsewhere bring out very clearly the differences in the amounts of nutrients and energy required by the organisms of different persons under different conditions. A large amount of work will be needed, however, to bring the experimental data necessary for accurate generalizations. The importance of the subject is such as to call for the most extensive and painstaking research. We may confidently expect that with the growth of inquiry, which has of late become so rapid in Europe, and may be anticipated in the United States, the needed information will gradually accumulate.

STUDIES OF DIETARIES.

REPORTED BY W. O. ATWATER AND A. P. BRYANT.

Accounts of studies of dietaries of families, boarding houses, and clubs made by the Station have been given in previous reports as follows:

1. A boarding house. (1)
2. A chemist's family. (1)
3. A jeweler's family. (2)
4. A blacksmith's family. (2)
5. A machinist's family. (2)
6. A mason's family. (2)
7. A carpenter's family. (2)
8. A carpenter's family. (2)
9. The family of the Station Agriculturist in winter. (3)
10. A mason's family (the same as No. 6). (3)
11. A carpenter's family (the same as No. 8). (3)
12. A College students' club. (3)
13. The family of the Station Agriculturist in summer. (3)
14. A widow's family. (4)
15. A Swedish laborer's family. (4)
16. A College club. (4)
17. A Divinity School club. (4)
18. A College lady students' club. (4)
19. A Swedish laborer's family (same as No. 15). (4)
20. Three chemists. (4)
21. A carpenter's family. (4)
25. An infant nine months old. (5)
26. A chemist's family. (5)
27. A farmer's family. (5)
28. A chemist's family (same as No. 26). (5)
29. A chemist's family (same as No. 26). (5)
45. A farmer's family. (5)
46. A farmer's family (same as No. 45). (5)
120. A farmer's family. (5)
121. A farmer's family. (5)
123. A farmer's family. (5)
124. A College students' eating club. (5)

Nine additional studies are here reported:

23. A family in Hartford.
24. A laborer's family in Hartford.
156. A farmer's family (same as No. 120).
157. A farmer's family (same as No. 121).
164. The family of the Station Agriculturist.
173. A private boarding house.
174. A farmer's family (same as No. 27).
175. A man in the Adirondacks under treatment for consumption.
176. A camping party in Maine.

Dietary studies 23 and 24 were conducted in Hartford by Miss Helen M. Hall, under the joint auspices of the Hartford School of Sociology and the Station. Nos. 156 and 157 were

(1) Report of this Station, 1891, pp. 90–106. (2) *Ibid*, 1892, pp. 135–162. (3) *Ibid*, 1893, pp. 174–197. (4) *Ibid*, 1894, pp. 174–204. (5) *Ibid*, 1895, pp. 129–174.

made by Prof. J. L. Bridge, who was at the time connected with the Connecticut Literary Institute, Suffield. They were, like Nos. 45, 46, 120, and 121, conducted by the Station in coöperation with the U. S. Department of Agriculture. No. 164 was made by Prof. C. S. Phelps at Storrs. No. 173 was made by Dr. Almah J. Frisby, who was at the time studying in the chemical laboratory of Wesleyan University. No. 174 was, like No. 27, conducted by Mr. A. W. Smith in Vermont. The data for No. 75 were kindly furnished by the subject, who made the study of his own dietary. Those of No. 176 are due to the courtesy of a member of the party.

The analyses, where such seemed called for and feasible, were made mostly by Mr. H. M. Burr.

PURPOSE OF THE INVESTIGATIONS.

The purpose of these investigations is to accumulate definite information regarding the practice of people of different classes, and in different places, in respect to the purchase and use of their food. Such information, coupled with that which comes from the study of the composition, digestibility, and nutritive value of our common food materials on the one hand, and on the other with that which comes from research into the laws of nutrition, including such as is illustrated by the metabolism experiments reported in the previous pages, will gradually make it possible to judge as to what are the more common dietary errors and how improvements may be made to the advantage of health, purse, and home life. To this end, however, much painstaking research will be necessary. It is very fortunate that a considerable number of experiment stations, colleges, and other organizations, as well as private individuals, in different parts of the country, are coöperating in such inquiries under the leadership of the U. S. Department of Agriculture, so that the much needed knowledge is accumulating much more rapidly than would otherwise be possible.

PLAN OF THE INVESTIGATIONS.

The general plan of the investigations includes the determination of the amounts and nutritive value of the food consumed by a given number of persons during a certain number of days, and the deducing of the quantities per man per day.

In the study of the dietary of a family, boarding house, or boarding club, account is taken of the amounts, composition, and cost of all food materials of nutritive value in the house at the beginning, purchased during, and remaining at the end of the experiment, and of all the kitchen and table wastes. The accessories, as baking powder, essences, salt, condiments, tea, coffee, etc., though of interest from a pecuniary standpoint, are of practically no value as regards nutriments. The amounts of different food materials on hand at the beginning and received during the experiment are added; from this sum the amounts remaining at the end are subtracted. This gives the amount of each material actually used. From the amount thus obtained and the composition of each material, as shown by analysis, the amounts of the nutritive ingredients are estimated. From these are subtracted the amounts of nutrients in the waste, and thus the amounts of the nutrients actually eaten are learned. Account is kept of the meals taken by the different members of the family, and by visitors. The number of meals for one man, to which the total number of actual meals taken is equivalent, is estimated upon the basis of the potential energy, as has been done in previous investigations here. These energy equivalents, which are stated below, are somewhat arbitrary, and will require revision in the light of accumulating inquiry.

Estimated relative quantities of potential energy in nutrients required by persons of different classes.

Man at moderate work,	1.0
Woman at moderate work,	.8
Boy between 14 and 16, inclusive,	.8
Girl between 14 and 16, inclusive,	.7
Child between 10 and 13, inclusive,	.6
Child between 6 and 9, inclusive,	.5
Child between 2 and 5, inclusive,	.4
Child under 2,	.3

Two of the studies, Nos. 175 and 176, were somewhat exceptional, as is explained in the special descriptions of the individual studies beyond.

In each study the data regarding the kinds and amounts of food materials, the persons by whom they were eaten, and the number of days and meals, were sent to the Station at Middletown, where the necessary computations were made. The

analyses were made from specimens of the food materials collected with the statistical data of the studies, and sent with them to the Station. The computations have been under the supervision of Mr. A. P. Bryant.

EXPLANATION OF TABLES.

The following statements and tables contain the main results of the inquiries, including all the data used in the computations. In order to reduce the bulk of the statistics, however, some of the details given in previous reports are omitted here. The statistics of each dietary include the kinds of food materials used, with the weight and cost of each.

Composition of food materials.—The figures used for the percentages of nutrients in each food material may be found in tables 17 and 60. The reference number opposite each material is that for the corresponding material in table 17. Those marked "a" in the former table represent results of analyses of samples of the food materials actually used in the respective dietaries. The number of materials of which such special analyses were made was, however, small. For the rest of the food materials, which make up the large majority of the whole, the composition was assumed from the averages given for like food materials in Bulletin 28 of the Office of Experiment Stations of the Department of Agriculture.* The figures in that Bulletin represent the results of a compilation of analyses made previous to January 1, 1895, and were used for computing the nutrients in the dietaries published in the last (1895) as well as the present report of this Station. Table 60 beyond gives the composition of a number of food materials as revised to January 1, 1896. Some of the figures of this latter table are the same as those for 1895 in the Bulletin just named, others have been slightly altered. The materials, of which the figures for composition actually employed for the computations differ from those in table 60, are included in table 17, and are indicated by the reference numbers, which are the same as those in the lists with the several dietaries. Those materials for which the figures for composition used in the computations are the same as in table 60 are indicated in the lists by the letter "M" in the column of reference numbers.

* On the Composition of American Food Materials, by W. O. Atwater and C. D. Woods.

Details of individual dietaries.—In the introductory statement for each dietary the number of meals for one man equivalent to those actually eaten are computed by use of the figures for relative amounts of potential energy in nutrients as above explained. In dietary No. 23, for instance, the man had 42 meals during the whole period of two weeks. The three women had together 105 meals. Assuming that a woman eats 0.8 as much as a man, these 105 meals of women would be equivalent to 84 meals for a man. In like manner the 42 meals for the child are estimated as equivalent to 17 meals for a man. The sum, 143 meals for a man, would be equivalent to three meals per day for 48 days.

The first table for each dietary shows the actual weights and costs of the different food materials for the whole period of the study in each case.

The second table in each dietary shows the weights of the food materials, the weights of the nutritive ingredients, and the costs, as calculated for one man for ten days. It shows also the percentages which the different kinds of food and the nutrients contained in it make of the total food and the total nutrients.

For the sake of simplicity and convenience, the computed quantities for one man for ten days are given, instead of the actual quantities consumed, or the quantities for one man for one day. If the quantities were stated as actually consumed in the period of each dietary, it would not be easy to compare the quantities in different dietaries. By putting the quantities for all of the dietaries on one basis, however, the relative amounts of the different kinds of food materials, as meats, milk, bread and the like in the different dietaries are readily compared. If the quantities were given per man per day, some would be too small for printing without the use of an inconvenient number of decimal places. To learn the amounts per man per day it is necessary only to remove the decimal point one place to the left.

The third table in each dietary gives the nutrients and energy in the total food purchased during the actual period of the experiment, the proportions in the table and kitchen wastes, and those in the food actually eaten.

In estimating the fuel values of the nutritive ingredients, the protein and carbohydrates are assumed to contain 4.1 and

the fats 9.3 calories of potential energy per gram. These correspond to 1,860 calories for one pound of protein or carbohydrates and 4,220 calories for one pound of fats.

Waste.—The words "refuse" and "waste" are used somewhat indiscriminately. In general, refuse in animal food represents inedible material, although bone, tendon, etc., which are classed as refuse, may be utilized for soup. The refuse of vegetable foods, such as parings, seeds, etc., represent not only inedible material, but also more or less of edible material. The waste includes the edible portion of the food, as pieces of meat, bread, etc., which might be saved, but is actually thrown away with the refuse.

In the studies here described the refuse and waste were separated so far as practicable and the latter was collected, dried, and analyzed. No attempt has been made in these investigations until recently to keep the animal wastes and the vegetable wastes separate, but rough calculations have been made of the nutrients of the waste which came from the animal and of those which came from the vegetable food.* Inasmuch, however, as different families do not waste the same kinds of food in the same proportions, the plan has been adopted of separating the animal and vegetable wastes wherever practicable.

But while this latter method gives the actual amount of animal and vegetable protein and carbohydrates wasted, it does not necessarily show the relative amounts of animal and vegetable fat wasted, because of the use of animal fats such as those in suet, lard, butter, and milk, in the cooking of vegetable foods such as bread, cake, etc. It follows, therefore, that the vegetable waste may contain a considerable amount of animal fat. This was shown in an exaggerated form in dietary studies recently made at the Maine State College† where, in one instance, the fat in the vegetable waste, largely bread and pastry, was larger than the actual amount of fat in the raw material of the vegetable foods consumed. No attempt is here made to distinguish between animal and vegetable fat in the wastes.

* See Report of this Station, 1895, pp. 131, 132.

† Bulletin No. 37, Office of Experiment Stations, U. S. Department of Agriculture.

TABLE 17.

Percentages of nutrients in food materials as used in the calculations of the following dietaries.

Food Materials.	Ref. No.	Protein.	Fat.	Carbohydrates.
Edible Portion.[1]		%	%	%
Beef.				
Round,	1	19.7	13.5	—
Rump,	2	16.8	25.6	—
Corned,	3	15.6	25.4	—
Veal.				
Rib,	4	20.2	6.2	—
Lamb.				
Leg,	5	18.5	16.5	—
Loin,	6	17.6	28.3	—
Shoulder,	7	17.5	29.7	—
Mutton.				
Loin,	8	15.9	33.2	—
Pork.				
Bacon,	9	10.0	67.2	—
Eggs,	10	14.9	10.6	—
Carrots,	11	1.1	.4	9.2
Celery,	12	1.4	.1	3.0
Onions,	13	1.7	.4	9.9
Parsnips,	14	1.7	.6	16.1
Peas, green,	15	4.4	.5	16.1
Potatoes,	16	2.1	.1	18.0
Sweet Potatoes,	17	1.8	.7	27.1
Squash,	18	1.6	.6	10.4
Turnips,	19	1.4	.2	8.7
Apples,	20	.5	.5	16.6
Bananas,	21	1.2	.8	22.9
Grapes,	22	1.3	1.7	17.7
Prunes,	23	2.4	.8	68.9
Raisins,	24	2.5	4.7	74.7
Cherries,	25	1.1	.8	11.4
As Purchased.[2]				
Beef.				
Brisket,	26	12.5	31.9	—
Round,	27	18.1	12.6	—
Round *(a)*,	28	19.8	3.7	—
Round *(a)*,	29	19.9	10.1	—
Round, 2d cut,	30	14.0	5.8	—
Rump,	31	13.2	20.2	—
Shoulder steak *(a)*,	32	18.4	12.6	—
Tripe,	33	10.9	1.2	—
Corned,	34	14.4	22.0	—
Bologna,	35	18.6	18.2	—
Veal.				
Neck,	36	13.3	4.6	—
Shoulder,	37	16.6	8.7	—

Food Materials.	Ref. No.	Protein.	Fat.	Carbohydrates.
As Purchased.[2]		%	%	%
Lamb.				
Leg,	38	15.2	13.6	—
Side,	39	14.2	18.7	—
Mutton.				
Leg,	40	14.9	14.9	—
Loin,	41	13.2	28.6	—
Loin *(a)*,	42	15.5	21.1	—
Loin *(a)*,	43	13.9	30.5	—
Neck,	44	11.7	17.6	—
Pluck,[3]	45	21.8	8.5	3.5
Pork.				
Loin *(a)*,	46	14.4	25.8	—
Bacon,	47	9.2	61.8	—
Fat, salt,	48	1.8	87.2	—
Sausage,	49	12.8	45.4	.8
Sausage *(a)*,	50	17.0	55.0	—
Poultry.				
Chicken, canned,	51	20.5	30.0	—
Fish.				
Smelts,	52	10.0	1.0	—
Salmon, canned,	53	20.7	10.8	1.2
Eggs,	54	13.1	9.5	—
Cheese,	55	26.0	34.2	2.3
Cheese, Dutch,	56	37.1	17.7	—
Cheese, Neufchatel	57	18.7	27.4	1.5
Milk *(a)*,	58	3.4	5.2	5.0
Milk *(a)*,	59	3.7	4.8	3.1
Milk,[4]	60	3.3	5.0	5.0
Skim milk *(a)*,	61	3.7	1.7	4.9
Buckwheat, prep'd,	62	7.9	1.2	74.9
Buckwheat flour,	63	6.1	1.0	77.2
Corn meal,	64	8.9	2.2	75.1
Bread flour,	65	11.3	1.1	74.6
Bread flour *(a)*,	66	13.2	1.2	75.1
Bread flour *(a)*,	67	10.1	1.3	76.8
Bread flour *(a)*,	68	13.3	.6	75.1
Pastry flour *(a)*,	69	10.4	1.0	75.6
Pastry flour *(a)*,	70	10.8	.4	76.8
Pastry flour *(a)*,	71	11.1	.3	76.4
Graham flour,	72	13.7	2.2	70.3
Crushed wheat,	73	11.9	1.7	74.5
Rolled oats,	74	16.9	7.2	66.8
Oatmeal,	75	15.6	7.3	68.0
Oatmeal *(a)*,	76	18.0	7.8	65.2
Rice,	77	7.8	.4	79.0
Mellin's food,	78	11.0	.3	80.6

TABLE 17.—*(Continued.)*

FOOD MATERIALS.	Ref. No.	Protein.	Fat.	Carbo-hydrates.	FOOD MATERIALS.	Ref. No.	Protein.	Fat.	Carbo-hydrates.
AS PURCHASED.		%	%	%	AS PURCHASED.		%	%	%
Rye meal, - -	79	7.1	.9	78.5	Spinach, - -	104	2.1	.5	3.1
Macaroni, - -	80	11.7	1.6	72.9	Turnips, - -	105	1.0	.1	6.1
Bread, white, -	81	9.5	1.2	52.8	Tomatoes, canned,	106	1.2	.2	4.0
Bread, graham, -	82	8.5	1.8	55.9	Apples, - -	107	.4	.4	12.4
Crackers, milk, -	83	9.3	13.1	69.2	Apples, dried, -	108	1.4	3.0	57.6
Crackers, soda, -	84	10.3	9.4	70.5	Bananas, - -	109	.7	.5	13.7
Crackers, pilot bread	85	12.4	4.4	74.2	Blackberries, -	110	.8	2.1	56.4
Cake, - - -	86	7.0	8.1	63.4	Crab apples, canned	111	.3	2.4	34.4
Cake, fruit, - -	87	6.6	10.5	64.7	Currants, dried, -	112	1.2	3.0	65.7
Cake, chocolate, -	88	5.7	9.4	66.1	Jelly, - - -	113	1.1	—	77.1
Ginger bread, -	89	5.4	9.5	64.7	Pineapples, canned,	114	.4	.7	36.4
Sugar cookies, -	90	6.8	8.9	75.3	Oranges, - -	115	.6	.4	7.1
Doughnuts, - -	91	6.6	21.9	52.6	Prunes, dried, -	116	2.0	.7	58.6
Mince pie, - -	92	6.5	12.1	37.2	Raspberries, -	117	1.0	—	12.6
Molasses, - -	93	2.7	—	68.0	Cocoanut, shredded	118	6.3	57.4	31.5
Honey, - -	94	—	—	75.0					
Corn starch, -	95	—	—	98.0					
Chocolate, - -	96	12.5	47.1	26.8	Waste *(a)*, - -	119	20.3	29.0	46.2
					Waste *(a)*, - -	120	15.5	40.4	39.9
Asparagus, - -	97	1.8	.2	3.3	Waste *(a)*, - -	121	20.4	51.1	9.0
Cabbage, - -	98	1.8	.3	4.9	Waste *(a)*, - -	122	13.1	12.9	69.6
Carrots, - -	99	.9	.3	7.4	Waste *(a)*, - -	123	19.7	36.6	35.6
Onions, - -	100	1.5	.4	8.9	Waste *(a)*, - -	124	33.0	58.0	—
Peas, dried, - -	101	24.1	1.1	61.5	Waste *(a)*, - -	125	—	100.	—
Potatoes, - -	102	1.8	.1	15.3	Waste *(a)*, - -	126	7.3	12.6	74.0
Potato chips, -	103	7.6	35.5	50.6	Accumulated fat,	127	—	95.0	—

[1] The term "edible portion" is applied to the food materials from which refuse, *i. e.*, bone of meat, shells of eggs, skins of potatoes, etc., had been removed when the weights as given in the detailed accounts of the dietaries beyond were made.

[2] The term "as purchased" indicates that the materials in this category were in the condition in which they were bought in the markets, whether they contained refuse, as the meats, or were free from refuse, as milk or bread.

[3] The "pluck" consists of parts of the heart, lungs, and liver. The composition is calculated from the probable proportion of each.

[4] The fat was estimated from the amount of milk required to make a pound of butter.

a The analyses marked "*a*" were made in connection with the dietaries in which they are used.

No. 23. DIETARY OF A FAMILY IN HARTFORD, CONN.

The study continued two weeks in the winter of 1894–95. The members of the family and number of meals taken were as follows:

Man, about 70 years old, - - - - - - -	42 meals.
Three women, between 35 and 50 years old (105 x .8), equivalent to - - - - - - - - - -	84 meals.
Girl, 5 years old (42 x .4), equivalent to - - - - -	17 meals.
Total number of meals taken equivalent to - -	143 meals.

Equivalent to one man 48 days.

Remarks.—The man had no employment. "One woman did dressmaking when she could obtain it to do; another went out washing: the third was a partial invalid." During the two weeks' investigation twenty-one meals were taken by the women away from home. These are not included in the number above.

TABLE 18.

Cost and weights of food materials used in dietary No. 23.

FOOD MATERIALS.	Reference No.	Cost.	WEIGHT. Pounds.	WEIGHT. Ounces.	FOOD MATERIALS.	Reference No.	Cost.	WEIGHT. Pounds.	WEIGHT. Ounces.
Beef.		$					$		
Round steak *(a)*,	28	.14	1	3.0	Eggs, - - -	54	.05	—	5.0
Round steak *(a)*,	29	.06	–	7.5	Butter, - -	M	.73	2	7.0
Short steak (loin),	M	.13	–	10.0	Milk, - - -	M	1.56	26	—
Tripe, - - -	33	.05	1	—	Condensed milk, -	M	.05	—	9.5
Corned, - -	34	.24	3	—	Buckwheat, prepared *(a)*, -	62	.12	1	3.0
Veal.					Flour *(a)*, - -	66	.73	32	8.0
Neck, - - -	36	.10	1	12.0	Bread, - -	81	.40	8	15.5
Mutton.					Crackers, milk, -	83	.14	1	6.0
Chops *(a)*, - -	42	.06	–	8.0	Cake, - - -	86	.10	—	3.5
Chops *(a)*, - -	43	.09	–	12.0	Mince pie, - -	92	.36	3	12.0
Chops (avg. 42.43),	—	.12	1	—	Sugar, granulated,	M	.64	14	12.5
Neck, - - -	44	.10	2	8.0	Cabbage, - -	98	.05	1	8.0
Pork.					Onions, - -	100	.03	1	4.0
Sausage *(a)*, -	50	.15	1	8.5	Potatoes, - -	102	.30	24	—
Lard, - - -	M	.08	–	13.0	Apples, - -	107	.15	8	14.0
Fish.					Oranges, - -	115	.13	1	—
Cod, boneless, -	M	.03	–	4.5	Waste *(a)*, - -	119	—	—	2.5

TABLE 19.

Weights and percentages of food materials and nutritive ingredients used in dietary of a family in Hartford. Calculated for one man 10 days.

Food Materials.	Weights in Pounds. Total Food.	Protein.	Fat.	Carbo-hydrates.	Weights in Grams. Protein.	Fat.	Carbo-hydrates.	Cost.	Fuel Value.
Animal Food.	Lbs.	Lbs.	Lbs.	Lbs.	Grams	Grams	Grams	$	Cal.
Beef,	1.3	.20	.18	—	92	82	—	.13	—
Veal,	.4	.05	.02	—	22	8	—	.02	—
Mutton,	1.0	.13	.21	—	59	97	—	.08	—
Pork,	.5	.05	.35	—	24	157	—	.05	—
Poultry,	—	—	—	—	—	—	—	—	—
Fish, etc.,	—	.01	—	—	6	—	—	.01	—
Eggs,	.1	.01	.01	—	4	3	—	.01	—
Butter,	.5	—	.42	—	—	190	—	.15	—
Cheese,	—	—	—	—	—	—	—	—	—
Milk,	5.5	.19	.22	.34	86	102	152	.33	—
Total animal food,	9.3	.64	1.41	.34	293	639	152	.78	7760
Vegetable Food.									
Corn meal, rye flour, & buckwheat flour,	.2	.02	—	.19	9	1	84	.03	—
Wheat flours,	6.8	.89	.08	5.08	406	37	2306	.15	—
Oatmeal, rice, and wheat preparations,	—	—	—	—	—	—	—	—	—
Bread, crackers, etc.,	3.0	.26	.16	1.50	117	72	682	.21	—
Sugar and starches,	3.1	—	—	3.08	—	—	1397	.13	—
Total cereals, etc.,	13.1	1.17	.24	9.85	532	110	4469	.52	—
Beans and peas,	—	—	—	—	—	—	—	—	—
Potatoes,	5.0	.09	.01	.76	41	2	347	.06	—
Other vegetables,	.6	.01	—	.04	4	1	17	.02	—
Total vegetables,	5.6	.10	.01	.80	45	3	364	.08	—
Fruits,	2.0	.01	.01	.24	4	4	111	.06	—
Total vege'ble food,	20.7	1.28	.26	10.89	581	117	4944	.66	23740
Total food,	30.0	1.92	1.67	11.23	874	756	5096	1.44	31500
Percentages total food.	%	%	%	%				%	%
Beef, veal, & mutton,	8.9	19.8	24.8	—	—	—	—	15.8	—
Pork,	1.6	2.8	20.7	—	—	—	—	3.4	—
Poultry,	—	—	—	—	—	—	—	—	—
Fish, etc.,	.2	.7	—	—	—	—	—	.4	—
Eggs,	.2	.4	.4	—	—	—	—	.7	—
Butter,	1.7	—	25.1	—	—	—	—	10.6	—
Cheese,	—	—	—	—	—	—	—	—	—
Milk,	18.4	9.8	13.5	3.0	—	—	—	23.4	—
Total animal food,	31.0	33.5	84.5	3.0	—	—	—	54.3	24.6
Cereals, sugars, etc.,	43.6	60.9	14.6	87.7	—	—	—	36.1	—
Vegetables,	18.5	5.2	.4	7.1	—	—	—	5.5	—
Fruits,	6.9	.4	.5	2.2	—	—	—	4.1	—
Total vege'ble food,	69.0	66.5	15.5	97.0	—	—	—	45.7	75.4
Total food,	100.0	100.0	100.0	100.0	—	—	—	100.0	100.0

TABLE 20.

Nutrients and potential energy in food purchased, rejected, and eaten in dietary of a family in Hartford, Conn.

Food Materials.		Cost.	Nutrients. Protein.	Fat.	Carbo-hydrates.	Fuel Value.
For Family, 14 Days.		$	Grams.	Grams.	Grams.	Calories.
Food purchased,	Animal,	3.74	1405	3067	732	37280
	Vegetable,	3.15	2787	561	23736	113960
	Total,	6.89	4192	3628	24468	151240
Total waste,		—	14	20	33	380
Total food actually eaten,		6.89	4178	3608	24435	150860
Per Man per Day.						
Food purchased,	Animal,	.08	29	64	15	775
	Vegetable,	.06	58	12	495	2380
	Total,	.14	87	76	510	3155
Total waste,		—	—	1	1	15
Total food actually eaten,		.14	87	75	509	3140
Percentages of Total Food Purchased.		%	%	%	%	%
Food purchased,	Animal,	54.3	33.5	84.5	3.0	24.6
	Vegetable,	45.7	66.5	15.5	97.0	75.4
	Total,	100.0	100.0	100.0	100.0	100.0
Total waste,		—	.3	.6	.1	.2
Total food actually eaten,		100.0	99.7	99.4	99.9	99.8

No. 24. DIETARY OF A LABORER'S FAMILY, IN HARTFORD, CONNECTICUT.

The study began December, 1894, and continued 14 days. The members of the family and number of meals taken were as follows:

Man,	42 meals.
Woman, (42 x .8) equivalent to	34 meals.
Girl, 11 years old (42 x .6) equivalent to	25 meals.
Girl, 6 years old (42 x .5), equivalent to	21 meals.
Girl 4 years old (42 x .4), equivalent to	17 meals.
Boy, 2½ years old (42 x .4), equivalent to	17 meals.
Infant, equivalent to	12 meals.
Total number of meals taken equivalent to	168 meals.
Equivalent to one man 56 days.	

Remarks.—The father was a laborer in a coal yard, earning $8.00 per week when working full time. During the two weeks of this study he earned $8.83. The mother worked in the laundry when possible.

"They pay $8.00 per month rent for four rooms and a small shed room on the second floor. The rooms are decently furnished, and, being small, three of the rooms are warmed in winter by the cook stove. The mother before marriage worked as a servant, and understands cooking."

"The children are kept in the house nearly all the time, as the mother said they learned 'bad ways' if they played with the other children."

The father is an Irish-American, the mother was born in England.

Table 21.

Cost and weights of food materials in dietary of a laborer's family in Hartford, Conn.

Food Materials.	Ref. No.	Cost.	Weight. Lbs.	Weight. Ozs.	Food Materials.	Ref. No.	Cost.	Weight. Lbs.	Weight. Ozs.
Beef.		$					$		
Neck,	M	.20	2	—	Eggs,	54	.25	1	5.0
Shoulder steak *(a)*,	32	.55	5	—	Butter,	M	.65	2	—
Bologna sausage,	35	.10	1	—	Milk,	M	.98	30	9.0
Suet,	M	.02	—	6.0	Flour *(a)*,	67	.50	22	10.0
Veal.					Rice,	77	.23	2	14.0
Shoulder,	37	.32	4	—	Rolled oats *(a)*,	76	.14	2	5.5
Mutton.					Bread,	81	.85	13	2.0
Neck,	44	.30	5	—	Cookies and doughnuts,	90	.21	1	9.5
Breast,	M	.18	3	—	Sugar, granulated,	M	.55	11	—
Pluck,	45	.25	5	—	Beans, dried,	M	.20	3	13.5
Pork.					Onions,	100	.07	6	12.0
Spare rib *(a)*,	46	.43	5	—	Potatoes,	102	.66	51	12.0
Ham, edible portion *(a)*,	M	.91	5	7.5	Raisins,	24	.10	1	—
Salt, fat,	48	.18	1	8.0	Waste *(a)*,	120	—	—	8.5
Fish.									
Cod, salt,	M	.30	3	—					

TABLE 22.

Weights and percentages of food materials and nutritive ingredients used in dietary of a laborer's family in Hartford. Calculated for one man 10 days.

Food Materials.	Weights in Pounds.				Wts. in Grams.			Cost.	Fuel Value.
	Total Weight of Food.	Protein.	Fat.	Carbohydrates.	Protein.	Fat.	Carbohydrates.		
Animal Food.	Lbs.	Lbs.	Lbs.	Lbs.	Gr.	Gr.	Gr.	Cts.	Cal.
Beef,	1.5	.25	.24	—	113	110	—	.16	—
Veal,	.7	.12	.06	—	54	28	—	.06	—
Mutton,	2.3	.36	.38	.03	164	171	14	.13	—
Pork,	2.1	.28	.85	—	129	384	—	.27	—
Poultry,	—	—	—	—	—	—	—	—	—
Fish, etc.,	.5	.09	—	—	39	1	—	.05	—
Eggs,	.2	.03	.02	—	14	10	—	.04	—
Butter,	.4	—	.29	—	—	133	—	.12	—
Cheese,	—	—	—	—	—	—	—	—	—
Milk and cream,	5.5	.17	.22	.30	78	99	136	.17	—
Total animal food,	13.2	1.30	2.06	.33	591	936	150	1.00	11740
Vegetable Food.									
Corn meal, rye meal, and buckwheat flour,	—	—	—	—	—	—	—	—	—
Wheat flours,	4.1	.41	.05	3.11	185	24	1408	.09	—
Oatmeal, rice, and wheat preparations,	.9	.12	.04	.68	53	16	308	.06	—
Bread, crackers, etc.,	2.6	.24	.05	1.45	110	24	658	.19	—
Sugars and starches,	2.0	—	—	1.96	—	—	891	.10	—
Total cereals and sugars,	9.6	.77	.14	7.20	348	64	3265	.44	—
Beans and peas,	.7	.15	.01	.41	69	6	184	.04	—
Potatoes,	9.2	.17	.01	1.41	76	4	641	.12	—
Other vegetables,	1.2	.02	.01	.11	8	2	49	.01	—
Total vegetables,	11.1	.34	.03	1.93	153	12	874	.17	—
Fruit,	.2	—	.01	.13	2	4	61	.02	—
Total vegetable food,	20.9	1.11	.18	9.26	503	80	4200	.63	20020
Total food,	34.1	2.41	2.24	9.59	1094	1016	4350	1.63	31760
Percentages of Total Food.	%	%	%	%	%	%	%	%	%
Beef, veal, and mutton,	13.3	30.3	30.4	.3	—	—	—	21.0	—
Pork,	6.3	11.8	37.9	—	—	—	—	16.7	—
Poultry,	—	—	—	—	—	—	—	—	—
Fish, etc.,	1.5	3.5	.1	—	—	—	—	3.3	—
Eggs,	.7	1.3	1.0	—	—	—	—	2.8	—
Butter,	1.0	—	13.1	—	—	—	—	7.1	—
Cheese,	—	—	—	—	—	—	—	—	—
Milk,	16.0	7.1	9.7	3.2	—	—	—	10.7	—
Total animal food,	38.8	54.0	92.2	3.5	—	—	—	61.6	37.0

TABLE 22.—*(Continued.)*

FOOD MATERIALS.	WEIGHTS IN POUNDS.				WTS. IN GRAMS.			Cost.	Fuel Value.
	Total Weight of Food.	Protein.	Fat.	Carbo-hydrates.	Protein.	Fat.	Carbo-hydrates.		
Percentages of Total Food. (Continued.)	Lbs.	Lbs.	Lbs.	Lbs.	Gr.	Gr.	Gr.	Cts.	Cal.
Cereals, sugars, etc.,	28.1	31.8	6.2	75.0	—	—	—	27.1	—
Vegetables,	32.6	14.0	1.2	20.1	—	—	—	10.2	—
Fruits,	.5	.2	.4	1.4	—	—	—	1.1	—
Total vegetable food,	61.2	46.0	7.8	96.5	—	—	—	38.4	63.0
Total food,	100.0	100.0	100.0	100.0	—	—	—	100.0	100.0

TABLE 23.

Nutrients and potential energy in food purchased, rejected and eaten in dietary of a laborer's family in Hartford, Conn.

FOOD MATERIALS.		Cost.	NUTRIENTS.			Fuel Value.
			Protein.	Fat.	Carbo-hydrates.	
For Family, 14 Days.		$	Grams.	Grams.	Grams.	Calories.
Food purchased,	Animal,	5.62	3312	5239	1076	66710
	Vegetable,	3.51	2816	444	23519	112100
	Total,	9.13	6128	5683	24595	178810
Waste,	Total,	—	38	99	98	1480
Food actually eaten,	Total,	9.13	6090	5584	24497	177330
Per Man per Day.						
Food purchased,	Animal,	.10	59	94	15	1175
	Vegetable,	.06	50	8	420	2000
	Total,	.16	109	102	435	3175
Waste,	Total,	—	1	2	2	30
Food actually eaten,	Total,	.16	108	100	433	3165
Percentages of Total Food Purchased.		%	%	%	%	%
Food purchased,	Animal,	61.6	54.0	92.2	3.5	37.3
	Vegetable,	38.4	46.0	7.8	96.5	62.7
	Total,	100.0	100.0	100.0	100.0	100.0
Waste,	Total,	—	.6	1.7	.4	.8
Food actually eaten,	Total,	100.0	99.4	98.3	99.6	99.2

No. 156. DIETARY OF A FARMER'S FAMILY IN CONNECTICUT.

(SAME FAMILY AS DIETARY NO. 120.)

The study began April 17, 1896, and continued 10 days. The members of the family and number of meals taken were as follows:

Man, about 60 years old, - - - - - - -	30 meals.
Man, 35 years old, - - - - - - - - - -	30 meals.
Man, 30 years old, - - - - - - - - - -	30 meals.
Woman, about 60 years old (30 x .8), equivalent to - -	24 meals.
Woman, about 30 years old (30 x .8), equivalent to - -	24 meals.
Girl, 7 years old (30 x .5), equivalent to - - - - -	15 meals.
Girl, 4 years old (30 x .4), equivalent to - - - - -	12 meals.
Total number of meals taken equivalent to - -	165 meals.

Equivalent to one man 55 days.

Remarks.—The family consisted of a man and his wife, two sons, a daughter-in-law, and two grand-children.

TABLE 24.

Weights of food materials used in dietary of a farmer's family in Connecticut.

FOOD MATERIALS.	Reference No.	WEIGHT. Pounds.	WEIGHT. Ounces.	FOOD MATERIALS.	Reference No.	WEIGHT. Pounds.	WEIGHT. Ounces.
*Beef.**							
Sirloin (loin), -	M	6	8.0	Flour, pastry *(a)*,	70	6	8.0
Round steak, -	1	2	—	Flour, entire wheat,	M	2	—
Shoulder clod, -	M	4	—	Flour, buckwheat,	63	1	12.5
Rump, - - - -	2	4	—	Corn meal, - -	64	1	6.5
Corned, - - -	3	3	.5	Rolled oats, - -	74	1	5.0
Dried and smoked,	M	—	8.5	Sugar, granulated,	M	10	—
				Sugar, brown, -	M	1	3.0
Pork.				Molasses, - -	93	1	2.0
Smoked shoulder, -	M	4	11.0	Crackers, - -	83	1	6.5
Fat, salt, - -	48	7	13.5	Rice, - - - -	77	—	10.0
Lard, - - - -	M	2	4.5	Gingerbread, -	89	1	—
				Sugar cookies, -	90	2	3.0
Fish.				Doughnuts, - -	91	2	—
Haddock, fresh, -	M	4	—	Maple syrup, -	M	4	5.0
Cod, salt, boneless,	M	1	8.5	Beans, dried, -	M	3	7.5
Mackerel, salt, -	M	2	8.0	Potatoes, edible portion, - -	16	36	8.0
Eggs, - - - -	54	5	1.0	Parsnips, edible portion, - -	14	6	—
Butter, - - - -	M	4	10.0	Squash, canned, -	M	2	—
Cheese, - - - -	55	—	10.5	Potato chips, -	103	—	8.0
Milk *(a)*, - -	58	84	4.0	Spinach, - -	104	3	—
Milk, skimmed, not eaten *(a)*, - -	61	31	11.0	Bananas, - -	109	10	—
				Oranges, - -	115	9	5.0
Animal waste *(a)*,	121	5	6.5	Quince jelly,† -	113	1	6.5
Vegetable waste *(a)*,	122	5	7.5	Currants, dried, -	112	—	5.0
				Raisins, - -	24	—	5.0
Flour, bread *(a)*, -	68	8	—	Prunes, - -	116	2	11.0

* The weights of all meats are without bone. † Composition assumed.

TABLE 25.

Weights and percentages of food materials and nutritive ingredients used in dietary of a farmer's family. Calculated for one man 10 days.

Food Materials.	Weights in Pounds.				Weights in Grams.			Fuel Value.
	Total Wgt. Food.	Protein.	Fat.	Carbo-hydrates.	Protein.	Fat.	Carbo-hydrates.	
Animal Food.	Lbs.	Lbs.	Lbs.	Lbs.	Grams.	Grams.	Grams.	Calories
Beef,	3.64	.67	.70	—	303	319	—	—
Veal,	—	—	—	—	—	—	—	—
Mutton,	—	—	—	—	—	—	—	—
Pork,	2.69	.16	1.94	—	73	877	—	—
Poultry,	—	—	—	—	—	—	—	—
Fish, etc.,	1.46	.20	.08	—	90	37	—	—
Eggs,	.93	.11	.09	—	55	40	—	—
Butter,	.84	—	.69	—	—	314	—	—
Cheese,	.12	.03	.04	—	14	18	1	—
Milk and cream,	9.55	.31	.70	.48	139	317	219	—
Total animal food,	19.23	1.48	4.24	.48	674	1922	220	21540
Vegetable Food.								
Corn meal, rye meal, and buckwheat flour,	.58	.04	.01	.44	19	4	201	—
Wheat flours,	3.00	.37	.02	2.26	169	9	1024	—
Oatmeal, rice, and wheat preparations,	.35	.05	.02	.25	22	8	113	—
Bread, crackers, etc.,	1.20	.09	.16	.79	39	75	357	—
Sugars and starches,	3.02	.01	—	2.71	3	—	1230	—
Total cereals and sugars,	8.15	.56	.21	6.45	252	96	2925	—
Beans and peas,	.63	.14	.01	.37	64	5	169	—
Potatoes,	6.72	.15	.04	1.25	67	18	567	—
Other vegetables,	2.00	.03	.01	.23	15	5	104	—
Total vegetables,	9.35	.32	.06	1.85	146	28	840	—
Fruit,	4.37	.04	.03	.93	17	11	421	—
Total vegetable food,	21.87	.92	.30	9.23	415	135	4186	20100
Total food,	41.10	2.40	4.54	9.71	1089	2057	4406	41640
Percentages Total Food.	%	%	%	%				%
Beef, veal, and mutton,	8.9	27.8	15.5	—	—	—	—	—
Pork,	6.6	6.7	42.7	—	—	—	—	—
Poultry,	—	—	—	—	—	—	—	—
Fish, etc.,	3.6	8.3	1.8	—	—	—	—	—
Eggs,	2.2	5.0	1.9	—	—	—	—	—
Butter,	2.0	—	15.3	—	—	—	—	—
Cheese,	.3	1.3	.9	—	—	—	—	—
Milk,	23.2	12.8	15.4	5.0	—	—	—	—
Total animal food,	46.8	61.9	93.5	5.0	—	—	—	51.7
Cereals, sugars, etc.,	19.8	23.1	4.7	66.4	—	—	—	—
Vegetables,	22.8	13.4	1.3	19.1	—	—	—	—
Fruits,	10.6	1.6	.5	9.5	—	—	—	—
Total vegetable food,	53.2	38.1	6.5	95.0	—	—	—	48.3
Total food,	100.0	100.0	100.0	100.0	—	—	—	100.0

TABLE 26.

Nutrients and potential energy in food purchased, rejected, and eaten in dietary of a farmer's family in Connecticut.

Food Materials.		Nutrients. Protein.	Fat.	Carbo-hydrates.	Fuel Value.
For Family, 10 days.		Grams.	Grams.	Grams.	Calories.
Food purchased,	Animal,	3707	10566	1214	118440
	Vegetable,	2282	741	23019	110630
	Total,	5989	11307	24233	229070
Waste,	Animal,	501	*	221	—
	Vegetable,	324	*	1723	—
	Total,	825	1573	1944	25985
Food actually eaten,*	Animal,	3206	*	993	—
	Vegetable,	1958	*	21296	—
	Total,	5164	9734	22289	203085
Per Man per Day.					
Food purchased,	Animal,	67	192	22	2150
	Vegetable,	42	14	419	2020
	Total,	109	206	441	4170
Waste,	Animal,	9	*	4	—
	Vegetable,	6	*	31	—
	Total,	15	29	35	475
Food actually eaten,	Animal,	58	*	18	—
	Vegetable,	36	*	388	—
	Total,	94	177	406	3695
Percentages of Total Food Purchased.		%	%	%	%
Food purchased,	Animal,	61.9	93.5	5.0	51.7
	Vegetable,	38.1	6.5	95.0	48.3
	Total,	100.0	100.0	100.0	100.0
Waste,	Animal,	8.4	*	.9	—
	Vegetable,	5.4	*	7.1	—
	Total,	13.8	13.9	8.0	11.3
Food actually eaten,	Animal,	53.5	*	4.1	—
	Vegetable,	32.7	*	87.9	—
	Total,	86.2	86.1	92.0	88.7

* The animal and vegetable wastes were kept separate, but inasmuch as more or less animal fat used in cooking must occur in the vegetable waste, the analysis does not show the real amount of vegetable fat wasted. For this reason no attempt is made to distinguish between animal and vegetable fat in the waste, and consequently the fuel value of the animal and vegetable waste cannot be calculated.

No. 157. DIETARY OF A FARMER'S FAMILY IN CONNECTICUT.

(Same Family as No. 121.)

The study began May 4, 1896, and continued 10 days. The family consisted of a man, his wife and his two sisters. The number of meals taken were as follows:

Man, about 40 years old, - - - - - - - -	30 meals.
Woman, about 35 years old (30 x .8), equivalent to - -	24 meals.
Woman, about 42 years old (30 x .8), equivalent to - -	24 meals.
Woman, about 35 years old (30 x .8), equivalent to - -	24 meals.
Total number of meals taken equivalent to - - -	102 meals.

Equivalent to one man 34 days.

Remarks.—"The man rented his farm, and at the time of the dietary did about two days' work per week. The women had quite active exercise. With the exception of the wife, all were below the average weight. The health of all was fair." The man weighed about 135 lbs., and the women about 150, 100, and 110 lbs., respectively.

Table 27.

Weights of food materials used in dietary of a farmer's family in Connecticut.

Food Materials.	Reference No.	Weight. Pounds.	Weight. Ounces.	Food Materials.	Reference No.	Weight. Pounds.	Weight. Ounces.
*Beef.**				Eggs, - - - -	54	3	—
				Butter, - - -	M	4	—
Short steak (loin), -	M	4	12.0	Milk *(a)*, -	59	22	—
Shoulder clod, - -	M	4	—	Skim milk *(a)*, -	61	7	4.0
				Flour, pastry *(a)*, -	71	17	8.0
Veal.				Rolled oats, - -	74	—	14.5
Steak, - - - -	M	1	2.0	Cookies, sugar, -	90	1	—
				Crackers, milk, - -	83	1	—
				Sugar, granulated, -	M	5	—
Lamb.				Sugar, brown, - -	M	—	12.0
Chops, - - - -	6	1	14.5	Molasses, - - -	93	—	4.0
				Tapioca, - - -	M	—	3.0
Pork.				Potatoes, edible portion, - - - -	16	21	12.0
Ham, - - - -	M	4	3.0	Asparagus, - -	97	3	4.0
Bacon, - - - -	9	—	9.0	Rhubarb, - - -	M	2	—
Lard, - - - -	M	1	1.0	Cocoanut, shredded, -	118	—	4.0

* The weights of all meats are without bone.

TABLE 28.

Weights and percentages of food materials and nutritive ingredients used in dietary of a farmer's family. Calculated for one man 10 days.

FOOD MATERIALS.	WEIGHTS IN POUNDS.				WEIGHTS IN GRAMS.			Fuel Value.
	Total Weight of Food.	Protein.	Fat.	Carbo-hydrates.	Protein.	Fat.	Carbo-hydrates.	
Animal Food.	Lbs.	Lbs.	Lbs.	Lbs.	Gr.	Gr.	Gr.	Cal.
Beef,	2.6	.48	.41	—	219	188	—	—
Veal,	.3	.07	.03	—	31	15	—	—
Mutton,	.5	.10	.16	—	45	72	—	—
Pork,	1.7	.21	.91	—	94	411	—	—
Poultry,	—	—	—	—	—	—	—	—
Fish, etc.,	—	—	—	—	—	—	—	—
Eggs,	.9	.11	.08	—	52	38	—	—
Butter,	1.2	—	.97	—	—	440	—	—
Cheese,	—	—	—	—	—	—	—	—
Milk and skim milk,	8.6	.32	.35	.30	145	157	137	—
Total animal food,	15.8	1.29	2.91	.30	586	1321	137	15250
Vegetable Food.								
Corn meal, rye meal, and buckwheat flour,	—	—	—	—	—	—	—	—
Wheat flours,	5.1	.57	.01	3.93	259	7	1784	—
Oatmeal, rice, and wheat preparation,	.3	.05	.02	.18	21	8	81	—
Bread, crackers, etc.,	.6	.05	.07	.43	21	30	194	—
Sugars and starches,	1.8	—	—	1.78	1	—	808	—
Total cereals and sugars,	7.8	.67	.10	6.32	302	45	2867	—
Beans and peas,	—	—	—	—	—	—	—	—
Potatoes,	6.4	.13	.01	1.15	61	3	522	—
Other vegetables,	1.5	.02	—	.05	9	2	20	—
Total vegetables,	7.9	.15	.01	1.20	70	5	542	—
Fruit,	.1	.01	.04	.02	2	19	11	—
Total vegetable food,	15.8	.83	.15	7.54	374	69	3420	16200
Total food,	31.6	2.12	3.06	7.84	960	1390	3557	31450
Percentages of Total Food.	%	%	%	%	%	%	%	%
Beef, veal, and mutton,	11.0	30.7	19.8	—	—	—	—	—
Pork,	5.4	9.8	29.5	—	—	—	—	—
Poultry,	—	—	—	—	—	—	—	—
Fish, etc.,	—	—	—	—	—	—	—	—
Eggs,	2.8	5.5	2.7	—	—	—	—	—
Butter,	3.7	—	31.7	—	—	—	—	—
Cheese,	—	—	—	—	—	—	—	—
Milk and skim milk,	27.1	15.0	11.3	3.9	—	—	—	—
Total animal food,	50.0	61.0	95.0	3.9	—	—	—	48.5

TABLE 28.—*(Continued.)*

Food Materials.	Weights in Pounds. Total Weight of Food.	Protein.	Fat.	Carbo-hydrates.	Weight in Grams. Protein.	Fat.	Carbo-hydrates.	Fuel Value.
Percentages of Total Food. (Continued.)	%	%	%	%	%	%	%	%
Cereals, sugars, etc., - -	24.7	31.5	3.3	80.6	—	—	—	—
Vegetables, - - - -	25.1	7.3	.3	15.2	—	—	—	—
Fruits, - - - - -	.2	.2	1.4	.3	—	—	—	—
Total vegetable food, -	50.0	39.0	5.0	96.1	—	—	—	51.5
Total food, - - -	100.0	100.0	100.0	100.0	—	—	—	100.0

TABLE 29.

Nutrients and potential energy in food purchased, rejected, and eaten in dietary of a farmer's family in Connecticut.

Food Materials.		Nutrients. Protein.	Fat.	Carbo-hydrates.	Fuel Value.
For Family, 10 Days.		Grams.	Grams.	Grams.	Calories
Food purchased and eaten,* -	Animal, -	1992	4492	471	51870
	Vegetable, -	1272	236	11627	55080
	Total, -	3264	4728	12098	106950
Per Man per Day.					
Food purchased and eaten, -	Animal, -	59	132	14	1525
	Vegetable, -	37	7	342	1620
	Total, -	96	139	356	3145
Percentages of Total Food Purchased.		%	%	%	%
Food purchased and eaten, -	Animal, -	61.0	95.0	3.9	48.5
	Vegetable, -	39.0	5.0	96.1	51.5
	Total, -	100.0	100.0	100.0	100.0

* There was no waste in this dietary.

No. 169. DIETARY OF THE STATION AGRICULTURIST'S FAMILY.

The study began November 9, 1895, and continued 28 days. The members of the family and number of meals taken were as follows:

Man, 34 years old; weight, 185 lbs., - - - - -	78 meals.
Woman, 28 years old; weight, 140 lbs. (81 x .8), equivalent to	65 meals.
Child, 3½ years old; weight, 41 lbs. (83 x .4), equivalent to	33 meals.
Child, 2 years old; weight, 34 lbs. (82 x .4), equivalent to -	33 meals.
Servant, 60 years old; weight, 145 lbs. (82 x .8), equivalent to	66 meals.
Visitor, male, - - - - - - - - - - - -	2 meals.
Total number of meals taken equivalent to - -	277 meals.

Equivalent to one man 92 days.

TABLE 30.

Cost and weights of food materials used in dietary of the Station Agriculturist's family.

Food Materials.	Reference No.	Cost.	Weight. Pounds.	Weight. Ounces.	Food Materials.	Reference No.	Cost.	Weight. Pounds.	Weight. Ounces.
Beef.		$					$		
Loin, - - -	M	.32	2	.5	Chocolate cake, -	88	.06	—	3.0
Shoulder, - -	M	.56	4	10.0	Macaroni, - -	80	.09	—	8.0
Round, - - -	27	.71	5	15.5	Rice, - - -	77	.08	—	15.0
Round, 2d cut, -	30	.32	3	9.0	Sugar, granulated,	M	1.00	17	—
Rump, - - -	31	.54	5	7.0	Sugar, maple, -	M	.02	—	2.0
Fore shank, - -	M	.38	9	9.0	Syrup, maple, -	M	.08	—	15.5
Sirloin steak (loin),	M	.31	1	14.5	Molasses, - -	93	.17	2	12.5
Dried and smoked,	M	.10	—	9.0	Honey, - -	94	.07	—	6.0
Lamb.					Cocoa, - - -	M	.05	—	2.0
Hind leg, - -	38	.34	3	6.0	Beans, dried, -	M	.05	1	1.5
Side, without tallow,	39	.82	10	3.5	Carrots (43% refuse),	11	.01	—	3.0
Pork.					Celery (12% refuse),	12	.30	2	9.5
Ham, - - -	M	.08	—	12.0	Onions (11.6% re-				
Lard and cottolene,	M	.51	1	5.5	fuse), - -	13	.03	—	13.5
Poultry.					Potatoes (23.7% re-				
Chicken, ed. portion,	M	.39	2	4.5	fuse), - -	16	.26	29	3.5
Fish.					Potatoes (15% refuse)	16	.03	4	4.0
Halibut steak, -	M	.60	2	15.5	Sweet potatoes (21				
Mackerel, fresh, -	M	.11	—	10.0	% refuse), - -	17	.06	2	—
Cod, salt, boneless,	M	.04	—	11.5	Squash (36.3% re-				
Eggs, - - -	54	.16	—	12.5	fuse), - -	18	.20	9	15.5
Butter, - - -	M	2.38	8	8.0	Turnips (23% refuse)	19	.04	3	10.0
Cheese, - - -	55	.12	—	10.5	Tomatoes, canned,	106	.10	1	2.5
Cheese, cottage, -	56	.10	—	9.0	Apples, wormy (41				
Milk, - - -	M	2.94	147	1.5	% refuse), - -	20	.42	16	7.0
Accumulated fat not					Apples, good (23.4				
used, - - -	127	—	1	8.5	% refuse), - -	20	.11	5	6.5
					Bananas (25% refuse)	21	.25	1	2.0
Corn meal, - -	64	—	—	3.0	Grapes (19% refuse),	22	.65	11	—
Wheat preparations,	M	.58	6	14.5	Raisins (18.7% re-				
Oatmeal, - -	74	.01	—	2.5	fuse), - -	24	.05	—	4.5
Flour, bread, -	65	.60	29	13.5	Canned fruit,* -	114	2.25	8	15.5
Flour, pastry, -	69	.22	11	13.5	Crab apple jelly,† -	113	.05	—	10.0
Mellin's food, -	78	.59	1	1.5					
Crackers, milk, -	83	.37	4	7.0	Waste *(a)*, - -	123	—	1	6.5

* Composition assumed; home canned; cost of fruit and sugar estimated at 25 cents per quart can. † Composition assumed.

TABLE 31.

Weights and percentages of food materials and nutritive ingredients used in dietary of the Station Agriculturist's family. Calculated for one man 10 days.

Food Materials.	Weights in Pounds. Total Weight of Food.	Weights in Pounds. Protein.	Weights in Pounds. Fat.	Weights in Pounds. Carbo-hydrates.	Wts. in Grams. Protein.	Wts. in Grams. Fat.	Wts. in Grams. Carbo-hydrates.	Cost.	Fuel Value.
Animal Food.	Lbs.	Lbs.	Lbs.	Lbs.	Gr.	Gr.	Gr.	$	Cal.
Beef,	3.7	.55	.43	—	248	194	—	.35	—
Veal,	—	—	—	—	—	—	—	—	—
Mutton,	1.5	.21	.26	—	97	117	—	.13	—
Pork,	.2	.01	.17	—	5	79	—	.06	—
Poultry,	.2	.05	.04	—	21	17	—	.04	—
Fish, etc.,	.5	.07	.02	—	34	8	—	.08	—
Eggs,	.1	.01	.01	—	5	3	—	.02	—
Butter,	.9	—	.76	—	—	346	—	.26	—
Cheese,	.1	.04	.03	.04	19	16	16	.03	—
Milk and cream,	16.0	.53	.64	.80	239	290	363	.32	—
Total animal food,	23.2	1.47	2.36	.84	668	1070	379	1.29	—
Accumulated fat not used,	.2	—	.16	—	—	73	—	—	—
Total animal food used,	23.0	1.47	2.20	.84	668	997	379	1.29	13560
Vegetable Food.									
Corn meal, rye meal, and buckwheat flour,	—	—	—	.01	1	—	6	—	—
Wheat flours,	4.5	.50	.05	3.39	227	22	1538	.09	—
Oatmeal, rice, and wheat preparations,	1.0	.11	.01	.75	49	6	342	.14	—
Bread, crackers, etc.,	.6	.05	.07	.39	24	30	176	.05	—
Sugars and starches,	2.3	.01	—	2.18	5	2	988	.15	—
Total cereals and sugars,	8.4	.67	.13	6.72	306	60	3050	.43	—
Beans and peas,	.1	.03	—	.07	12	1	32	.01	—
Potatoes,	3.9	.08	.01	.72	36	2	324	.04	—
Other vegetables,	2.0	.03	.01	.17	14	4	78	.07	—
Total vegetables,	6.0	.14	.02	.96	62	7	434	.12	—
Fruit,	4.8	.03	.04	1.06	15	19	482	.41	—
Total vegetable food,	19.2	.84	.19	8.74	383	86	3966	.96	18630
Total food,	42.2	2.31	2.39	9.58	1051	1083	4345	2.25	32190
Percentages of Total Food.	%	%	%	%	%	%	%	%	%
Beef, veal, and mutton,	12.2	32.8	28.7	—	—	—	—	21.3	—
Pork,	.5	.5	7.3	—	—	—	—	2.8	—
Poultry,	.6	2.0	1.6	—	—	—	—	1.9	—
Fish, etc.,	1.1	3.2	.7	—	—	—	—	3.6	—
Eggs,	.2	.5	.3	—	—	—	—	.8	—
Butter,	2.2	—	31.9	—	—	—	—	11.5	—

TABLE 31.—*(Continued.)*

Food Materials.	Weights in Pounds. Total Weight of Food.	Protein.	Fat.	Carbo-hydrates.	Wts. in Grams. Protein.	Fat.	Carbo-hydrates.	Cost.	Fuel Value.
Percentages of Total Food. (Continued.)	%	%	%	%	%	%	%	%	%
Cheese, - - - - -	.3	1.8	1.5	.4	—	—	—	1.1	—
Milk, - - - - -	37.9	22.7	26.8	8.3	—	—	—	14.2	—
Total animal food, -	55.0	63.5	98.8	8.7	—	—	—	57.2	—
Accumulated fat not used,	.4	—	6.7	—	—	—	—	—	—
Total animal food used,	54.6	63.5	92.1	8.7	—	—	—	57.2	42.1
Cereals, sugars, etc., -	19.9	29.1	5.6	70.2	—	—	—	19.3	—
Vegetables, - - -	14.2	5.9	.6	10.0	—	—	—	5.2	—
Fruits, - - - -	11.3	1.5	1.7	11.1	—	—	—	18.3	—
Total vegetable food, -	45.4	36.5	7.9	91.3	—	—	—	42.8	57.9
Total food, - -	100.0	100.0	100.0	100.0	—	—	—	100.0	100.0

TABLE 32.

Nutrients and potential energy in food purchased, rejected, and eaten in dietary of the Station Agriculturist's family.

Food Materials.		Cost.	Nutrients. Protein.	Fat.	Carbo-hydrates.	Fuel Value.
For Family, 28 Days.		$	Grams.	Grams.	Grams.	Calories
Food purchased,	Animal,	11.83	6144	9175	3487	124810
	Vegetable,	8.85	3528	789	36487	171400
	Total,	20.68	9672	9964	39974	296210
Waste,	Animal,	—	79	213	20	2390
	Vegetable,	—	45	18	204	1190
	Total,	—	124	231	224	3580
Food actually eaten,	Animal,	—	6065	8962	3467	122420
	Vegetable,	—	3483	771	36283	170210
	Total,	—	9548	9733	39750	292630
Per Man per Day.						
Food purchased,	Animal,	.13	67	100	38	1360
	Vegetable,	.09	38	8	397	1860
	Total,	.22	105	108	435	3220
Waste,	Animal,	—	1	3	—	30
	Vegetable,	—	—	—	2	10
	Total,	—	1	3	2	40
Food actually eaten,	Animal,	—	66	97	38	1330
	Vegetable,	—	38	8	395	1850
	Total,	—	104	105	433	3180
Percentages of Total Food Purchased.		%	%	%	%	%
Food purchased,	Animal,	57.2	63.5	92.1	8.7	42.1
	Vegetable,	42.8	36.5	7.9	91.3	57.9
	Total,	100.0	100.0	100.0	100.0	100.0
Waste,	Animal,	—	.8	2.1	.1	.8
	Vegetable,	—	.5	.2	.5	.4
	Total,	—	1.3	2.3	.6	1.2
Food actually eaten,	Animal,	—	62.7	90.0	8.6	41.3
	Vegetable,	—	36.0	7.7	90.8	57.5
	Total,	—	98.7	97.7	99.4	98.8

No. 173. DIETARY OF A PRIVATE BOARDING HOUSE IN MIDDLETOWN, CONN.

The study began October 19, 1896, and continued 7 days. The members of the household consisted of seven adults, two men and five women. One man was elderly and not engaged in any active work; the other was a young and active clergyman. Two of the women were middle aged and three young. All were in good health and actively occupied. The number of meals taken was as follows:

Two men,	39 meals.
Five women (105 x .8), equivalent to	84 meals.
Total number of meals taken equivalent to	123 meals.

Equivalent to one man 41 days.

TABLE 33.

Cost and weights of food materials used in dietary of private boarding house in Middletown, Conn.

Food Materials.	Reference No.	Cost.	Weight: Pounds.	Weight: Ounces.	Food Materials.	Reference No.	Cost.	Weight: Pounds.	Weight: Ounces.
*Beef.**		$					$		
Sirloin steak,	M	1.40	6	8.0	Cake,	87	.49	2	7.5
Short steak,	M	.16	—	14.0	Crackers,	84	.13	—	13.5
Shoulder,	M	.40	3	1.0	Macaroni,	80	.10	—	12.0
Dried and smoked,	M	.03	—	2.0	Sugar, granulated,	M	.39	7	3.0
Veal.					Syrup, maple,	M	.18	1	8.0
Rib roast,	4	.15	1	—	Beans, dried,	M	.06	1	10.5
Lamb.					Celery (56 % refuse),	12	.09	—	6.0
					Corn, canned,	M	.09	1	8.0
Neck and shoulder,	7	.25	2	2.5	Onions (7.3 % refuse),	13	.03	1	11.0
Leg,	5	.90	4	2.0	Potatoes (17.6 % refuse)	16	.18	13	14.5
Pork.					Sweet potatoes (20 % refuse),	17	.24	10	9.5
Salt, fat,	48	.01	—	2.0	Tomatoes, canned,	106	.08	2	8.0
Lard,	M	.16	1	6.5	Apples (38 % refuse),	20	.08	4	10.5
Poultry.					Bananas (38 % refuse),	21	.22	1	15.0
Chicken,	M	.72	2	15.5	Grapes (23.3 % refuse),	22	.15	1	10.0
Eggs,	10	.66	3	11.0	Prunes (25.7 % refuse),	23	.15	1	2.0
Butter,	M	1.04	3	15.5	*Accessories.*				
Cheese,	55	.10	—	14.0					
Cheese, cottage,	57	.05	—	6.0	Catsup,	—	.02	—	4.5
Milk,	M	1.02	31	4.5	Olives (27.5 % pit),	—	.17	—	5.0
Cream,	M	.48	4	—	Pickles,	—	.20	1	13.0
					Coffee,	—	.18	—	11.5
Corn meal,	64	.01	—	10.0	Tea,	—	.15	—	5.5
Flour, bread,	65	.20	9	1.0					
Flour, pastry,	69	.03	—	14.5	Animal waste *(a)*,	124	—	1	1.5
Rolled oats,	74	.09	1	8.0	Clear fat, waste *(a)*,	125	—	—	9.0
Rice,	77	.01	—	3.5	Vegetable waste *(a)*,	126	—	1	8.0

* All weights in this dietary are of the edible portion without refuse.

TABLE 34.

Weights and percentages of food materials and nutritive ingredients used in dietary of a private boarding house, Middletown, Conn. Calculated for one man 10 days.

Food Materials.	Weights in Pounds.				Wts. in Grams.			Cost.	Fuel Value.
	Total Weight of Food.	Protein.	Fat.	Carbohydrates.	Protein.	Fat.	Carbohydrates.		
Animal Food.	Lbs.	Lbs.	Lbs.	Lbs.	Gr.	Gr.	Gr.	$	Cal.
Beef,	2.6	.48	.45	—	219	204	—	.49	—
Veal,	.2	.05	.02	—	22	7	—	.04	—
Mutton,	1.5	.28	.32	—	126	146	—	.28	—
Pork,	.4	—	.38	—	—	169	—	.04	—
Poultry,	.7	.14	.11	—	63	50	—	.17	—
Fish, etc.,	—	—	—	—	—	—	—	—	—
Eggs,	.9	.13	.09	—	61	43	—	.16	—
Butter,	1.0	—	.80	—	—	361	—	.25	—
Cheese,	.3	.07	.10	.01	34	45	3	.04	—
Milk and cream,	8.6	.28	.48	.42	125	220	193	.37	—
Total animal food,	16.2	1.43	2.75	.43	650	1245	196	1.84	15050
Vegetable Food.									
Corn meal, rye meal, and buckwheat flour,	.1	.01	—	.11	6	1	51	—	—
Wheat flours,	2.5	.28	.03	1.82	124	12	824	.06	—
Oatmeal, rice, and wheat preparations,	.4	.07	.03	.29	30	12	131	.02	—
Bread, crackers, etc.,	1.0	.08	.08	.67	38	39	303	.18	—
Sugars and starches,	2.1	—	—	2.01	—	—	913	.14	—
Total cereals and sugars,	6.1	.44	.14	4.90	198	64	2222	.40	—
Beans and peas,	.4	.09	.01	.24	41	3	108	.02	—
Potatoes,	6.0	.12	.02	1.31	53	10	595	.10	—
Other vegetables,	1.5	.02	—	.14	12	3	63	.07	—
Total vegetables,	7.9	.23	.03	1.69	106	16	766	.19	—
Fruits,	2.3	.03	.02	.55	11	8	251	.14	—
Total vegetable food,	16.3	.70	.19	7.14	315	88	3239	.73	15390
Total food,	32.5	2.13	2.94	7.57	965	1333	3435	2.57	30440
Accessories,	.8	—	—	—	—	—	—	—	—
Percentages of Total Food.	%	%	%	%	%	%	%	%	%
Beef, veal, and mutton,	13.1	38.2	26.7	—	—	—	—	29.2	—
Pork,	1.1	—	12.7	—	—	—	—	1.5	—
Poultry,	2.2	6.5	3.8	—	—	—	—	6.4	—
Fish, etc.,	—	—	—	—	—	—	—	—	—
Eggs,	2.7	6.3	3.2	—	—	—	—	5.9	—
Butter,	2.9	—	27.1	—	—	—	—	9.2	—
Cheese,	.9	3.5	3.4	.1	—	—	—	1.3	—
Milk and cream,	25.8	12.9	16.5	5.6	—	—	—	13.4	—
Total animal food,	48.7	67.4	93.4	5.7	—	—	—	66.9	49.4
Cereals, sugars, etc.,	18.4	20.5	4.8	64.7	—	—	—	14.5	—
Vegetables,	23.6	11.0	1.2	22.3	—	—	—	6.9	—
Fruits,	6.8	1.1	.6	7.3	—	—	—	5.3	—
Total vegetable food,	48.8	32.6	6.6	94.3	—	—	—	26.7	50.6
Accessories,	2.5	—	—	—	—	—	—	6.4	—
Total food,	100.0	100.0	100.0	100.0	—	—	—	100.0	100.0

TABLE 35.

Nutrients and potential energy in food purchased, rejected, and eaten in dietary of a private boarding house, Middletown, Conn.

FOOD MATERIALS.		Cost.	Nutrients. Protein.	Fat.	Carbo-hydrates.	Fuel Value.
For Family, 7 Days.		$	Grams.	Grams.	Grams.	Calories
Food purchased,	Animal,	7.53	2665	5103	803	61680
	Vegetable,	3.72	1290	363	13280	63110
	Total,	11.25	3955	5466	14083	124790
Waste,	Animal,	—	162	*	—	—
	Vegetable,	—	17	*	168	—
	Total,	—	179	561	168	6640
Food actually eaten,	Animal,	7.53	2503	*	803	—
	Vegetable,	3.72	1273	*	13112	—
	Total,	11.25	3776	4905	13915	118150
Per Man per Day.						
Food purchased,	Animal,	.18	65	124	19	1495
	Vegetable,	.09	31	9	324	1540
	Total,	.27	96	133	343	3035
Waste,	Animal,	—	4	*	—	—
	Vegetable,	—	—	*	4	—
	Total,	—	4	14	4	160
Food actually eaten,	Animal,	.18	61	*	19	—
	Vegetable,	.09	31	*	320	—
	Total,	.27	92	119	339	2875
Percentages of Total Food Purchased.		%	%	%	%	%
Food purchased,	Animal,	66.9	67.4	93.4	5.7	49.4
	Vegetable,	33.1	32.6	6.6	94.3	50.6
	Total,	100.0	100.0	100.0	100.0	100.0
Waste,	Animal,	—	4.1	*	—	—
	Vegetable,	—	.4	*	1.2	—
	Total,	—	4.5	10.3	1.2	5.3
Food actually eaten,	Animal,	66.9	63.3	*	5.7	—
	Vegetable,	33.1	32.2	*	93.1	—
	Total,	100.0	95.5	89.7	98.8	94.7

* The animal and vegetable wastes were kept separate, but inasmuch as more or less animal fat used in cooking must occur in the vegetable waste, the analysis does not show the real amount of vegetable fat. For this reason no attempt is made to distinguish between animal and vegetable fat, and consequently the fuel value of the animal and vegetable waste cannot be calculated.

No. 174. DIETARY OF A FARMER'S FAMILY IN VERMONT.

The study began July 7, 1896, and continued 15⅓ days. The members of the family and number of meals taken were as follows:

Man, about 45 years old, - - - - - - -	46 meals.
Woman, about 45 years old (46 x .8), equivalent to - -	37 meals.
Man, 22 years old, - - - - - - - - - -	46 meals.
Boy, 19 years old, - - - - - - - - - -	46 meals.
Boy, 15 years old (46 x .8), equivalent to - - - - -	37 meals.
Girl, 16 years old (46 x .7), equivalent to - - - - -	32 meals.
Girl, 14 years old (46 x .7), equivalent to - - - - -	32 meals.
Girl, 4 years old (46 x .4), equivalent to - - - - -	18 meals.
Total number of meals taken equivalent to - -	294 meals.

Equivalent to one man 98 days.

Remarks.—This is a summer dietary of the same family whose dietary in winter was given in the Report of the Station for 1895 as No. 27. The family were all at rather active exercise, as the study was made in one of the busy seasons of the year.

TABLE 36.

Cost and weights of food materials used in dietary of a farmer's family in Vermont.

FOOD MATERIALS.	Reference No.	Cost.	WEIGHT. Pounds.	WEIGHT. Ounces.	FOOD MATERIALS.	Reference No.	Cost.	WEIGHT. Pounds.	WEIGHT. Ounces.
Beef.		$					$		
Brisket, - - -	26	.30	4	12.0	Corn meal, - -	64	.21	13	12.0
Ribs, - - - -	M	.60	6	—	Flour, graham, -	72	.29	7	4.0
Tripe, - - - -	33	.59	9	13.0	Flour, bread, -	65	.67	26	12.0
Corned, canned, -	M	.25	2	—	Oatmeal, - -	75	.05	2	—
Pork.					Rice, - - -	77	.04	—	9.0
					Rye meal, - -	79	.11	3	12.0
Ham, - - - -	M	.84	6	—	Bread, graham, -	82	.10	2	4.0
Salt, fat, - - -	48	.60	6	—	Crackers, - -	M	.20	2	—
Lard, - - - -	M	.13	1	4.0	Sugar, - - -	M	1.31	23	12.0
Fish.					Molasses, - -	93	.59	10	12.0
					Beans, dried, -	M	.30	10	—
Salt cod, boneless,	M	.05	—	7.0	Peas, green, shell'd,	15	.43	4	5.0
					Potatoes, ed. port'n,	16	.26	25	13.0
					Tomatoes, canned,	106	.22	3	—
Eggs, - - - -	54	1.75	14	—	Apples, dried, -	108	.16	1	10.0
Butter, - - -	M	1.40	7	—	Crab apples, can.,	111	.30	3	—
Cheese, - - -	55	.15	1	4.0	Cherries, fresh, -	25	.10	—	14.0
Milk, whole,* - -	60	1.40	70	—	Cherries, canned,†	110	.20	1	—
Buttermilk, - -	M	.26	25	7.5	Currants, fresh,†	25	1.00	15	6.0
Sour milk,* - -	60	.05	4	8.0	Raspberries, fresh,	117	.40	4	4.0
Cream, - - -	M	.30	3	—	Raspberries, can.,†	110	.50	2	—

* Fat estimated from the amount of the milk required to make a pound of butter.
Composition assumed.

TABLE 37.

Weights and percentages of food materials and nutritive ingredients used in dietary of a farmer's family in Vermont. Calculated for one man 10 day.

FOOD MATERIALS.	WEIGHTS IN POUNDS.				WTS. IN GRAMS.			Cost.	Fuel Value.
	Total Wgt. Food	Protein.	Fat.	Carbo-hydrates.	Protein.	Fat.	Carbo-hydrates.		
Animal Food.	Lbs.	Lbs.	Lbs.	Lbs.	Gms.	Gms.	Gms.	$	Calories
Beef,	2.3	.31	.33	—	141	147	1	.18	—
Veal,	—	—	—	—	—	—	—	—	—
Mutton,	—	—	—	—	—	—	—	—	—
Pork,	1.4	.09	.86	—	42	392	—	.16	—
Poultry,	—	—	—	—	—	—	—	—	—
Fish, etc.,	.1	.01	—	—	4	—	—	—	—
Eggs,	1.4	.19	.14	—	85	62	—	.18	—
Butter,	.7	—	.59	—	—	267	—	.14	—
Cheese,	.1	.03	.04	—	15	20	2	.02	—
Milk,	10.5	.34	.45	.52	153	206	235	.20	—
Total animal food,	16.5	.97	2.41	.52	440	1094	238	.88	12950
Vegetable Food.									
Corn meal, rye meal, and buckwheat flour,	1.8	.15	.03	1.35	69	15	614	.03	—
Wheat flours,	3.5	.41	.05	2.56	186	21	1160	.10	—
Oatmeal, rice, and wheat preparations,	.2	.04	.02	.18	16	7	83	.01	—
Bread, crackers, etc.,	.4	.04	.02	.27	19	11	122	.03	—
Sugars and starches,	3.5	.03	—	3.17	13	—	1438	.19	—
Total cereals and sugars	9.4	.67	.12	7.53	303	54	3417	.36	—
Beans and peas,	1.5	.25	.02	.68	112	10	306	.08	—
Potatoes,	2.6	.05	—	.47	25	1	215	.03	—
Other vegetables,	.3	—	—	.01	2	—	5	.02	—
Total vegetables,	4.4	.30	.02	1.16	139	11	526	.13	—
Fruit,	2.9	.03	.03	.68	13	15	307	.27	—
Total vegetable food,	16.7	1.00	.17	9.37	455	80	4250	.76	20040
Total food,	33.2	1.97	2.58	9.89	895	1174	4488	1.64	32990
Percentages Total Food.	%	%	%	%	%	%	%	%	%
Beef, veal, and mutton,	6.9	15.7	12.6	—	—	—	—	10.8	—
Pork,	4.1	4.7	33.4	—	—	—	—	9.7	—
Poultry,	—	—	—	—	—	—	—	—	—
Fish, etc.,	.1	.5	—	—	—	—	—	.3	—
Eggs,	4.3	9.5	5.2	—	—	—	—	10.9	—
Butter,	2.2	—	22.7	—	—	—	—	8.7	—
Cheese,	.4	1.7	1.7	—	—	—	—	.9	—
Milk,	31.6	17.0	17.6	5.3	—	—	—	12.5	—
Total animal food,	49.6	49.1	93.2	5.3	—	—	—	53.8	39.3
Cereals, sugars, etc.,	28.5	34.0	4.6	76.2	—	—	—	22.2	—
Vegetables,	13.3	15.5	.9	11.7	—	—	—	7.5	—
Fruits,	8.6	1.4	1.3	6.8	—	—	—	16.5	—
Total vegetable food,	50.4	50.9	6.8	94.7	—	—	—	46.2	60.7
Total food,	100.0	100.0	100.0	100.0	—	—	—	100.0	100.0

TABLE 38.

Nutrients and potential energy in food purchased, rejected, and eaten in dietary of a farmer's family in Vermont.

Food Materials.		Cost.	Nutrients. Protein.	Nutrients. Fat.	Nutrients. Carbo-hydrates.	Fuel Value.
For Family, 15⅓ Days.		$	Grams.	Grams.	Grams.	Calories.
Food purchased and eaten,	Animal,	8.67	4307	10724	2331	126950
	Vegetable,	—	4460	781	41644	196290
	Total, -	8.67	8767	11505	43975	323240
Per Man per Day.						
Food purchased and eaten,	Animal,	.09	44	109	24	1295
	Vegetable,	—	45	8	425	2000
	Total, -	.09	89	117	449	3295
Percentages of Total Food Purchased.		%	%	%	%	%
Food purchased and eaten,	Animal,	—	49.1	93.2	5.3	39.3
	Vegetable,	—	50.9	6.8	94.7	60.7
	Total, -	—	100.0	100.0	100.0	100.0

No. 175. DIETARY OF A MAN IN THE ADIRONDACKS IN MIDWINTER.

The study began January 25, 1896, and continued 30 days. Ninety meals were eaten, equivalent to one man 30 days. This study was carried on by a man 24 years of age, who is a consumptive and lives in the Adirondack region of Northern New York winter and summer. After boarding at hotels for several years he "determined to rent a cottage and keep house for himself." He planned to be out of doors several hours each day, though not engaged in muscular labor, and as the weather in winter was very cold, some times reaching 30° or 40° below zero Fahrenheit, this may in part account for the large amount of food eaten. The relative amount of animal food was much larger than is usually the case. The weighings of food materials were made "on a pair of reliable steelyards." The figures given represent the amounts actually eaten. None of the materials were analyzed. The data as reported by the author bore marks of much care as well as understanding of the subject.

TABLE 39.

Cost and weights of food materials used in dietary of a man in the Adirondacks in midwinter.

Food Materials.	Reference No.	Cost.	Weight. Pounds.	Weight. Ounces.	Food Materials.	Reference No.	Cost.	Weight. Pounds.	Weight. Ounces.
Beef.		$					$		
Rib roast,	M	1.85	10	4.0	Rye meal,	79	.03	—	12.0
Round,	27	2.35	16	13.0	Crushed wheat,	73	.22	2	5.0
Dried and smoked,	M	.03	—	5.0	Oatmeal,	74	.09	1	—
Mutton.					Flour,	65	.04	1	13.0
Leg,	40	.96	7	8.0	Macaroni,	80	.04	—	4.0
Chops (loin),	41	.82	4	4.0	Bread,	81	.26	5	11.0
					Sugar,	M	.25	1	14.0
Fish.					Molasses,	93	.08	1	8.0
Cod, fresh,	M	.53	4	9.0	Tapioca,	M	.02	—	3.0
Cod, salt,	M	.01	—	2.0	Corn starch,	95	.04	—	3.0
Smelts,	52	.08	—	8.0	Cocoa,	M	.25	—	8.0
Salmon, canned,	53	.15	1	—	Beans,	M	.03	—	12.0
					Carrots,	99	.01	—	3.0
Eggs,	54	.42	2	3.0	Onions,	100	.11	2	4.0
Butter,	M	1.10	3	8.0	Peas,	101	.04	—	14.0
Milk,	M	3.57	99	—	Potatoes,	102	.17	34	—
					Turnips,	105	.01	—	10.0
Corn meal,	64	.05	2	8.0	Tomatoes, canned,	106	.07	1	6.0

TABLE 40.

Nutrients and potential energy in food purchased, rejected and eaten in dietary of a man in the Adirondacks in midwinter.

Food Materials.		Cost.	Nutrients. Protein.	Nutrients. Fat.	Nutrients. Carbohydrates.	Fuel Value.
For Man, 30 Days.		$	Grams.	Grams.	Grams.	Calories.
Food eaten,	Animal,	11.87	4767	6274	2252	87120
	Vegetable,	1.81	1223	216	8769	42980
	Total,	13.68	5990	6490	11021	130100
Per Man per Day.						
Food eaten,	Animal,	.40	159	209	75	2905
	Vegetable,	.06	41	7	292	1430
	Total,	.46	200	216	367	4335
Percentages of Total Food Purchased.		%	%	%	%	%
Food eaten,	Animal,	86.8	79.6	96.7	20.4	67.0
	Vegetable,	13.2	20.4	3.3	79.6	33.0
	Total,	100.0	100.0	100.0	100.0	100.0

TABLE 41.

Weights and percentages of food materials and nutritive ingredients used in dietary of a man in the Adirondacks in midwinter. Calculated for one man 10 days.

Food Materials.	Weights in Pounds. Total Weight of Food.	Protein.	Fat.	Carbohydrates.	Wts. in Grams. Protein.	Fat.	Carbohydrates.	Cost.	Fuel Value.
	Lbs.	Lbs.	Lbs.	Lbs.	Gr.	Gr.	Gr.	$	Cal.
Animal Food.									
Beef,	9.1	1.51	1.44	—	683	654	—	1.41	—
Mutton,	3.9	.56	.78	—	254	353	—	.59	—
Fish, etc.,	2.1	.25	.04	—	115	18	2	.26	—
Eggs,	.7	.09	.07	—	43	31	—	.14	—
Butter,	1.2	—	.96	—	—	437	—	.37	—
Milk and cream,	33.0	1.09	1.32	1.65	494	598	749	1.19	—
Total animal food,	50.0	3.50	4.61	1.65	1589	2091	751	3.96	29040
Vegetable Food.									
Corn meal, rye meal, and buckwheat flour,	1.1	.09	.02	.83	42	9	373	.03	—
Wheat flours,	.6	.07	.01	.45	31	3	205	.01	—
Oatmeal, rice, and wheat preparations,	1.1	.15	.04	.80	67	17	362	.10	—
Bread, crackers, etc.,	2.0	.19	.02	1.06	86	11	482	.10	—
Sugars and starches,	1.4	.05	.05	1.14	23	22	520	.21	—
Total cereals and sugars,	6.2	.55	.14	4.28	249	62	1942	.45	—
Beans and peas,	.5	.13	.01	.33	57	3	148	.02	—
Potatoes,	11.3	.20	.01	1.73	93	5	786	.06	—
Other vegetables,	1.5	.02	—	.10	9	2	47	.07	—
Total vegetables,	13.3	.35	.02	2.16	159	10	981	.15	—
Fruit,	—	—	—	—	—	—	—	—	—
Total vegetable food,	19.5	.90	.16	6.44	408	72	2923	.60	14330
Total food,	69.5	4.40	4.77	8.09	1997	2163	3674	4.56	43370
Percentages of Total Food.	%	%	%	%	%	%	%	%	%
Beef, veal, and mutton,	18.8	46.9	46.5	—	—	—	—	43.9	—
Fish, etc.,	3.0	5.8	.8	—	—	—	—	5.6	—
Eggs,	1.0	2.2	1.5	—	—	—	—	3.1	—
Butter,	1.7	—	20.2	—	—	—	—	8.1	—
Milk,	47.4	24.7	27.7	20.4	—	—	—	26.1	—
Total animal food,	71.9	79.6	96.7	20.4	—	—	—	86.8	67.0
Cereals, sugars, etc.,	8.9	12.5	2.9	52.9	—	—	—	10.0	—
Vegetables,	19.2	7.9	.4	26.7	—	—	—	3.2	—
Total vegetable food,	28.1	20.4	3.3	79.6	—	—	—	13.2	33.0
Total food,	100.0	100.0	100.0	100.0	—	—	—	100.0	100.0

No. 176. DIETARY OF A CAMPING PARTY IN MAINE.

In the summer of 1895 four young men from 19 to 22 years of age spent some time canoeing and camping on the Allagash River, Maine. As they took their journey easily they may be considered as being engaged in light work. For part of the time they had a guide whose rations are included in the dietary. The whole time is estimated as equivalent to 115 days for one man. The following data as to the food consumption are from a record kept quite carefully by a member of the party. The weight of the fresh meat was approximate, and the composition was assumed to be that of average veal. No analysis of the food materials were made. While the estimates of quantities of nutrients lack the accuracy desirable in a dietary study they are yet of no little interest.

TABLE 42.

Weights of food materials used in dietary of a camping party in Maine.

FOOD MATERIALS.	Reference No.	WEIGHT.		FOOD MATERIALS.	Reference No.	WEIGHT.	
		Pounds.	Ounces.			Pounds.	Ounces.
Canned corned beef,	M	12	—	Oatmeal,	74	2	—
Fresh meat,	M	100	—	Rice,	77	12	—
				Hard-tack,	85	10	—
Pork.				Sugar, brown,	M	35	—
Salt, fat,	48	24	—	Chocolate,	96	8	—
Bacon,	47	21	—	Beans,	M	15	—
Ham,	M	18	—	Onions,	100	20	—
Lard,	M	8	—	Canned peas,	M	4	—
				Potatoes,	102	30	—
Canned chicken,	51	6	—	Apples, dried,	108	2	—
Cheese,	55	1	—	*Accessories.*			
Milk,	M	50	—	Coffee,	—	10	—
Condensed milk,	M	5	—	Tea,	—	—	8.0
Corn meal,	64	5	—	Baking powder,	—	5	—
Flour, wheat,	65	75	—	Salt,	—	2	8.0

TABLE 43.

Weights and percentages of food materials and nutritive ingredients used in dietary of a camping party in Maine. Calculated for one man 10 days.

Food Materials.	Weights in Pounds.				Weights in Grams.			Fuel Value.
	Total Weight Food.	Protein.	Fat.	Carbohydrates.	Protein.	Fat.	Carbohydrates.	
Animal Food.	Lbs.	Lbs.	Lbs.	Lbs.	Grams	Grams	Grams	Cal.
Beef,	8.7	.30	.14	—	135	66	—	—
Fresh meat,	1.0	1.31	.55	—	595	249	—	—
Pork,	6.2	.41	4.17	—	188	1890	—	—
Poultry,	.5	.11	.16	—	49	71	—	—
Cheese,	.1	.02	.03	—	10	14	1	—
Milk and cream,	4.8	18	.20	.45	81	93	202	—
Total animal food,	21.3	2.33	5.25	.45	1058	2383	203	27330
Vegetable Food.								
Corn meal, rye meal, and buckwheat flour,	.5	.04	.01	.33	18	4	148	—
Wheat flour,	6.5	.73	.07	4.86	334	32	2207	—
Oatmeal, rice, and wheat preparations,	1.2	.11	.02	.94	50	8	427	—
Bread, crackers, etc.,	.9	.11	.03	.65	49	17	293	—
Sugar and starches,	3.7	.09	.33	3.08	40	149	1396	—
Total cereals, etc.,	12.8	1.08	.46	9.86	491	210	4471	—
Beans and peas,	1.3	.29	.02	.77	132	11	350	—
Potatoes,	2.6	.05	—	.40	21	1	181	—
Other vegetables,	2.1	.04	.01	.19	18	3	86	—
Total vegetables,	6.0	.38	.03	1.36	171	15	617	—
Fruits,	.2	—	.01	.10	1	2	45	—
Total vegetable food,	19.0	1.46	.50	11.32	663	227	5133	25870
Total food,	40.3	3.79	5.75	11.77	1721	2610	5336	53200
Percentages of Total Food.	%	%	%	%	%	%	%	%
Beef, veal, and mutton,	24.2	42.5	12.1	—	—	—	—	—
Pork,	15.3	10.9	72.4	—	—	—	—	—
Poultry,	1.3	2.8	2.7	—	—	—	—	—
Cheese,	.2	.6	.5	—	—	—	—	—
Milk,	11.9	4.7	3.6	3.8	—	—	—	—
Total animal food,	52.9	61.5	91.3	3.8	—	—	—	51.4
Cereals, sugars, etc.,	31.8	28.5	8.0	83.8	—	—	—	—
Vegetables,	14.9	9.9	.6	11.6	—	—	—	—
Fruits,	.4	.1	.1	.8	—	—	—	—
Total vegetable food,	47.1	38.5	8.7	96.2	—	—	—	48.6
Total food,	100.0	100.0	100.0	100.0	—	—	—	100.0

TABLE 44.

Nutrients and potential energy in food purchased, rejected and eaten in dietary of a camping party in Maine.

FOOD MATERIALS.		NUTRIENTS. Protein.	Fat.	Carbo-hydrates.	Fuel Value.
For Party.		Grams.	Grams.	Grams.	Calories.
Food purchased, -	Animal, -	12169	27396	2331	314230
	Vegetable, -	7616	2625	59018	297610
	Total, -	19785	30021	61349	611840
Per Man per Day.					
Food purchased, -	Animal, -	106	238	20	2730
	Vegetable, -	66	23	513	2590
	Total, -	172	261	533	5320
Percentages of Total Food Purchased.		%	%	%	%
Food purchased, -	Animal, -	61.5	91.3	3.8	51.4
	Vegetable, -	38.5	8.7	96.2	48.6
	Total, -	100.0	100.0	100.0	100.0

SUMMARY OF THE RESULTS OF DIETARY STUDIES REPORTED BY THE STATION.

Table 45 gives a summary of the results of forty-one dietary studies reported in the present and previous Annual Reports of this Station. These are for convenience arranged into five groups: those of farmers' families, those of mechanics' families, those of the families of professional men, those of College students' clubs, and finally those which do not naturally come into either of the above classes. For the sake of comparison the average of each group is given.

The results are in all cases calculated to the same basis, "per man per day." Accordingly the figures for the College ladies' club represent larger quantities than were actually consumed. If they are multiplied by 0.8, the results will be the values "per woman per day," and will represent the amounts actually consumed in this study.

In each dietary the nutrients and fuel value, "per man per day," of the food purchased, wasted, and eaten, are shown together with the estimated digestible nutrients in the food eaten and its fuel value. These digestible nutrients were estimated by the use of the factors explained beyond.

The results of study 179, described beyond, are included in the summary table but are not in the averages.

TABLE 45.

Summary of dietary studies made by the Station.

Number.	Dietaries.	Nutrients. Protein.	Fat.	Carbo-hydrates.	Fuel Value.
	I.—DIETARY STUDIES AMONG FARMERS' FAMILIES.	Grams.	Grams.	Grams.	Cal.
	Two Dietaries of a Farmer's Family in Vermont.				
	Winter, 1895. (5)				
27	Food purchased and eaten, - - -	69	92	444	2960
	Estimated digestible nutrients in food eaten,	61	89	432	2850
	Summer, 1896. (6)				
174	Food purchased and eaten, - - -	89	117	449	3295
	Estimated digestible nutrients in food eaten,	81	113	438	3180
	Two Dietaries of a Farmer's Family in Connecticut.				
	December, 1894. (5)				
45	Food purchased and eaten, - - -	108	76	635	3755
	Estimated digestible nutrients in food eaten,	96	73	617	3600
	December, 1894. (6)				
46	Food purchased and eaten, - - -	109	91	608	3785
	Estimated digestible nutrients in food eaten,	97	88	592	3645
	Two Dietaries of a Farmer's Family in Connecticut.				
	Fall, 1795. (5)				
120	Food, Purchased, - - - - -	114	139	545	3995
	Food, Waste, - - - - - -	14	18	44	405
	Food, Eaten, - - - - - -	100	121	501	3590
	Estimated digestible nutrients in food eaten,	92	117	486	3460
	Spring, 1896. (6)				
156	Food, Purchased, - - - - -	109	206	441	4170
	Food, Waste, - - - - - -	15	29	35	475
	Food, Eaten, - - - - - -	94	177	406	3695
	Estimated digestible nutrients in food eaten,	87	171	394	3565
	Two Dietaries of a Farmer's Family in Connecticut.				
	Fall, 1895. (5)				
121	Food purchased and eaten, - - -	79	117	354	2865
	Estimated digestible nutrients in food eaten,	73	113	344	2760
	Spring, 1896. (6)				
157	Food purchased and eaten, - - -	96	139	356	3145
	Estimated digestible nutrients in food eaten,	89	134	349	3040

TABLE 45.—*(Continued.)*

Number.	Dietaries.	Nutrients. Protein.	Fat.	Carbo-hydrates.	Fuel Value.
	Dietary of a Farmer's Family in Connecticut (5).	Grams.	Grams.	Grams.	Cal.
123	Food, Purchased,	140	174	456	4060
	Food, Waste,	9	13	23	250
	Food, Eaten,	131	161	433	3810
	Estimated digestible nutrients in food eaten,	120	155	422	3665
	Average of Nine Dietaries as above.				
	Food, Purchased,	**101**	**128**	**476**	**3560**
	Food, Waste,	**4**	**7**	**11**	**125**
	Food, Eaten,	**97**	**121**	**465**	**3435**
	Estimated digestible nutrients in food eaten,	**88**	**117**	**453**	**3305**
	II.—DIETARY STUDIES AMONG MECHANICS' FAMILIES.				
	Dietary of a Boarding House. (1)				
1	Food, Purchased,	126	188	426	4010
	Food, Waste,	23	36	25	520
	Food, Eaten,	103	152	401	3490
	Estimated digestible nutrients in food eaten,	95	147	392	3365
	Dietary of a Blacksmith's Family. (2)				
4	Food, Purchased,	103	176	408	3730
	Food, Waste,	3	5	7	90
	Food, Eaten,	100	171	401	3640
	Estimated digestible nutrients in food eaten,	90	166	384	3485
	Dietary of a Machinist's Family. (2)				
5	Food, Purchased,	100	159	427	3640
	Food, Waste,	1	3	6	60
	Food, Eaten,	99	156	421	3580
	Estimated digestible nutrients in food eaten,	90	151	411	3460
	Two Dietaries of a Mason's Family. *December, 1892. (2)*				
6	Food, Purchased,	107	153	429	3620
	Food, Waste,	3	5	16	120
	Food, Eaten,	104	148	413	3500
	Estimated digestible nutrients in food eaten,	97	142	402	3370
	May, 1893. (3)				
10	Food, Purchased,	125	145	366	3365
	Food, Waste,	6	8	18	175
	Food, Eaten,	119	137	348	3190
	Estimated digestible nutrients in food eaten,	113	132	339	3080

TABLE 45.—*(Continued.)*

Number.	Dietaries.	Nutrients. Protein.	Fat.	Carbo-hydrates.	Fuel Value.
	Dietary of a Carpenter's Family. (2)	Grams.	Grams.	Grams.	Cal.
7	Food, Purchased,	125	152	498	3970
	Food, Waste,	11	17	23	300
	Food, Eaten,	114	135	475	3670
	Estimated digestible nutrients in food eaten,	106	130	463	3540
	Two Dietaries of a Carpenter's Family.				
	November, 1892. (2)				
8	Food, Purchased,	107	161	408	3610
	Food, Waste,	7	12	20	220
	Food, Eaten,	100	149	388	3390
	Estimated digestible nutrients in food eaten,	91	144	377	3260
	May, 1893. (3)				
11	Food, Purchased,	115	125	346	3055
	Food, Waste,	4	3	10	90
	Food, Eaten,	111	122	336	2965
	Estimated digestible nutrients in food eaten,	103	117	327	2850
	Dietary of a Carpenter's Family. (4)				
21	Food, Purchased,	104	118	471	3455
	Food, Waste,	3	8	1	90
	Food, Eaten,	101	110	470	3365
	Estimated digestible nutrients in food eaten,	92	106	458	3240
	Average of Nine Dietaries as above.				
	Food, Purchased,	**113**	**153**	**420**	**3605**
	Food, Waste,	**7**	**11**	**14**	**185**
	Food, Eaten,	**106**	**142**	**406**	**3420**
	Estimated digestible nutrients in food eaten,	**97**	**137**	**395**	**3295**
	III.—DIETARY STUDIES AMONG PROFESSIONAL MEN'S FAMILIES.				
	Dietary of a Chemist's Family. (1)				
2	Food purchased and eaten,	118	103	430	3210
	Estimated digestible nutrients in food eaten,	109	99	420	3090
	Dietary of a Jeweler's Family. (2)				
3	Food, Purchased,	91	126	483	3530
	Food, Waste,	8	9	5	140
	Food, Eaten,	83	117	478	3390
	Estimated digestible nutrients in food eaten,	74	111	463	3235

TABLE 45.—*(Continued.)*

Number.	Dietaries.	Protein.	Fat.	Carbo-hydrates.	Fuel Value.
		Nutrients.			
	Three Dietaries of Station Agriculturist's Family.	Grams.	Grams.	Grams.	Cal.
	Winter, 1893. (3)				
9	Food, Purchased,	106	145	405	3450
	Food, Waste,	7	6	7	115
	Food, Eaten,	99	139	398	3335
	Estimated digestible nutrients in food eaten,	92	133	389	3210
	Summer, 1893. (3)				
13	Food, Purchased,	133	150	475	3885
	Food, Waste,	4	5	3	85
	Food, Eaten,	129	145	472	3800
	Estimated digestible nutrients in food eaten,	119	140	461	3680
	Fall, 1895. (6)				
169	Food, Purchased,	105	108	435	3220
	Food, Waste,	1	3	2	40
	Food, Eaten,	104	105	433	3180
	Estimated digestible nutrients in food eaten,	97	101	421	3065
	Dietary of Three Chemists. (4)				
20	Food, Purchased,	121	166	551	4300
	Food, Waste,	5	8	16	160
	Food, Eaten,	116	158	535	4140
	Estimated digestible nutrients in food eaten,	106	152	520	3980
	Three Dietaries of a Chemist's Family.				
	November, 1895. (5)				
26	Food, Purchased,	104	122	385	3140
	Food, Waste,	2	24	7	260
	Food, Eaten,	102	98	378	2880
	Estimated digestible nutrients in food eaten,	97	94	367	2775
	February, 1895. (5)				
28	Food purchased and eaten,	91	150	399	3405
	Estimated digestible nutrients in food eaten,	84	144	389	3280
	May 15, 1895. (5)				
29	Food, Purchased,	124	155	414	3650
	Food, Waste,	2	8	4	100
	Food, Eaten,	122	147	410	3550
	Estimated digestible nutrients in food eaten,	114	141	400	3420
	Average of Nine Dietaries as above.				
	Food, Purchased,	**110**	**136**	**442**	**3530**
	Food, Waste,	**3**	**7**	**5**	**100**
	Food, Eaten,	**107**	**129**	**437**	**3430**
	Estimated digestible nutrients in food eaten,	**99**	**124**	**426**	**3305**

TABLE 45.—*(Continued.)*

Number.	Dietaries.	Nutrients. Protein.	Fat.	Carbo-hydrates.	Fuel Value.
	IV.—DIETARY STUDIES OF STUDENTS' CLUBS.	Grams.	Grams.	Grams.	Cal.
	Dietary of a College Students' Club. (3)				
12	Food, Purchased,	113	180	376	3680
	Food, Waste,	19	39	30	570
	Food, Eaten,	94	141	346	3110
	Estimated digestible nutrients in food eaten,	87	136	338	3005
	Dietary of a College Students' Club. (4)				
16	Food, Purchased,	113	160	343	3360
	Food, Waste,	9	24	17	330
	Food, Eaten,	104	136	326	3030
	Estimated digestible nutrients in food eaten,	97	131	319	2925
	Dietary of a Divinity School Club. (4)				
17	Food, Purchased,	138	185	356	3745
	Food, Waste,	16	47	39	660
	Food, Eaten,	122	138	317	3085
	Estimated digestible nutrients in food eaten,	115	134	310	2990
	Dietary of College Ladies' Eating Club. (4)				
18	Food, Purchased,	135	196	377	3920
	Food, Waste,	30	36	47	650
	Food, Eaten,	105	160	330	3270
	Estimated digestible nutrients in food eaten,	97	154	322	3150
	Dietary of a College Students' Club. (5)				
124	Food, Purchased,	137	186	557	4575
	Food, Waste,	33	30	63	675
	Food, Eaten,	104	156	494	3900
	Estimated digestible nutrients in food eaten,	96	150	483	3770
	Average of Five Dietaries as above.				
	Food, Purchased,	**127**	**181**	**402**	**3880**
	Food, Waste,	**21**	**35**	**39**	**575**
	Food, Eaten,	**106**	**146**	**363**	**3305**
	Estimated digestible nutrients in food eaten,	**98**	**141**	**354**	**3170**
	V.—MISCELLANEOUS DIETARY STUDIES.				
	Dietary of a Widow's Family. (4)				
14	Food, Purchased,	119	115	512	3655
	Food, Waste,	3	4	12	100
	Food, Eaten,	116	111	500	3555
	Estimated digestible nutrients in food eaten,	102	107	487	3410

TABLE 45.—(*Continued.*)

Number.	Dietaries.	Protein.	Fat.	Carbohydrates.	Fuel Value.
	Two Dietaries of a Swede Family. (4)	Grams.	Grams.	Grams.	Cal.
	March, 1894.				
15	Food, Purchased,	121	116	486	3565
	Food, Waste,	3	4	7	75
	Food, Eaten,	118	112	479	3490
	Estimated digestible nutrients in food eaten,	109	107	469	3365
	November, 1894.				
19	Food, Purchased,	137	129	651	4440
	Food, Waste,	4	6	15	140
	Food, Eaten,	133	123	636	4300
	Estimated digestible nutrients in food eaten,	123	119	622	4160
	Dietary of a Family in Hartford, Conn. (6)				
23	Food, Purchased,	87	76	510	3155
	Food, Waste,	—	1	1	15
	Food, Eaten,	87	75	509	3140
	Estimated digestible nutrients in food eaten,	77	72	498	3025
	Dietary of a Laborer's Family in Hartford, Conn. (6)				
24	Food, Purchased,	109	102	434	3175
	Food, Waste,	1	2	2	30
	Food, Eaten,	108	100	432	3145
	Estimated digestible nutrients in food eaten,	99	96	422	3030
	Dietary of a Private Boarding House. (6)				
173	Food, Purchased,	96	133	343	3035
	Food, Waste,	4	14	4	160
	Food, Eaten,	92	119	339	2875
	Estimated digestible nutrients in food eaten,	86	116	330	2785
	Dietary of a Man in the Adirondacks in Midwinter. (6)				
175	Food eaten,	200	216	367	4335
	Estimated digestible nutrients in food eaten,	190	209	358	4190
	Dietary of a Camping Party in Maine. (6)				
176	Food purchased,	172	261	533	5320
	Estimated digestible nutrients in food eaten,	159	251	521	5125
	Dietary of Sandow, "the Strong Man." (7)				
179	Food eaten,	244	151	502	4462

TABLE 45.—(*Continued.*)

Number.	Dietaries.	Nutrients. Protein.	Fat.	Carbo-hydrates.	Fuel Value.
	Average of Nine Dietaries above, except Nos. 175, 176 and 179.	Grams.	Grams.	Grams.	Cal.
	Food, Purchased,	112	112	488	3500
	Food, Waste,	3	5	7	90
	Food, Eaten,	109	107	481	3410
	Estimated digestible nutrients in food eaten,	99	103	471	3296
	Average of 38 Dietaries above (all except Nos. 175, 176 and 179.)				
	Food, Purchased,	111	140	447	3595
	Food, Waste,	7	11	13	185
	Food, Eaten,	104	129	434	3410
	Estimated digestible nutrients in food eaten,	96	124	423	3285

(1) Report of this Station, 1891, pp. 90-106. *(2) Ibid*, 1892, pp. 135-162. *(3) Ibid*, 1893, pp. 174-190. *(4) Ibid*, 1894, pp. 174-201. *(5) Ibid*, 1895, pp. 129-170. *(6)* This Report, pp. 117-158. *(7) Ibid*, pp. 158-162.

DIETARY STUDY OF SANDOW, THE "STRONG MAN."

BY C. F. LANGWORTHY, PH. D., AND W. H. BEAL.

The information regarding the diet of professional athletes is very limited. In 1870, dietary and metabolism experiments were made with the professional pedestrian, Weston.* He walked 317½ miles in five consecutive days, covering 92 miles

* Austin Flint, Jr.: New York Medical Journal, 1871, p. 609.

NOTE.—This report of a dietary study, which is of especial interest on account of the very remarkable strength as well as the muscular activity of the subject, has been kindly furnished by the authors for publication in the present Report. The observations were made in Washington, D. C. The authors express their appreciation not only of the interest which Mr. Sandow manifested in the investigations, but also of the kindness of the proprietor of the Hotel Regent and of Harvey's restaurant, where the observations were made. They also express the hope that it may be possible at some future time to make more extended and accurate experiments, which shall include the metabolism of the food consumed. For convenience in comparing with other dietaries studied by institutions coöperating with the Department of Agriculture, this is designated as No. 179 of the series. W. O. A.

in one day. His food consisted of beef extract, oat meal gruel, raw eggs, and a very little brandy and champagne. The diet was estimated to contain 82.5 grams of protein. During the five days immediately following the severe exercise his diet was much more abundant, including considerable meat. It was estimated to contain 181 grams of protein. The conclusion was reached that severe muscular exercise increased the metabolism of protein.

A dietary study was made of a college foot-ball team in active training at Wesleyan University in 1886.* The investigation was made toward the end of the foot-ball season, and although the exercise was vigorous, and at times severe, the members were of the opinion that they did not eat as heartily as earlier in the season. The diet contained 181 grams of protein. So far as is known, no other experiments have been made with athletes.

During an engagement of Mr. Eugen Sandow, the "strong man," in Washington, January, 1896, an attempt was made to determine the character and amount of the food he consumed. Mr. Sandow claims to be the strongest man in the world, and substantiates this claim by performing many wonderful feats of strength, one of which is the raising of a 300-pound dumb-bell above his head with one hand. He is a German by birth, and is now 29 years old; is 5 feet 9 inches tall, and weighs 200 pounds. His waist measures 28 inches; his chest, 47 inches, expanded 61 inches; upper arm, contracted 19½ inches; fore-arm, 16¼ inches; thigh, 27 inches; calf, 17½ inches; and neck, 18 inches. He states that in his youth he had no phenomenal muscular development, but acquired his present muscular condition by training. This training was begun nine years ago. At the present time he does not take regular muscular exercise other than his professional work. He has the appearance of perfect health.

Mr. Sandow does not follow any prescribed diet, but eats whatever he desires, always being careful to eat less than he craves, rather than more. He eats very slowly. He sleeps very late in the morning. Sometimes he takes a cup of weak tea and a little bread in the morning, but usually his first meal is eaten about noon. He eats again about 6 o'clock, and again

* W. O. Atwater: U. S. Dept. Agr., Office of Experiment Stations, Bulletin 21, p. 182.

about midnight, after his exhibition of feats of strength is over. He smokes a good deal, and drinks beer and other alcoholic beverages.

In the present experiment it was necessary to limit the period of observation to one day. The plan followed was to weigh each article of food as it was served to Mr. Sandow, and then weigh what was not consumed. Three meals were eaten; dinner and breakfast at the hotel where he was stopping, and supper at a restaurant. He rejected all the visible fat of the meat. No other marked peculiarity was observed.

In compiling the data obtained, the composition of the food was calculated from standard tables (Atwater's* and Konig's†). It was assumed that 1 gram of alcohol was equal to 1.71 grams of carbohydrates. The figures used are those given in table 46. The amount of food consumed at each meal, its composition, and the estimated fuel value are shown in table 47.

TABLE 46.

Estimates of composition of food materials used in computing the following dietary.

Food.	Composition.			Food.	Composition.		
	Protein.	Fat.	Carbo-hydrates.		Protein.	Fat.	Carbo-hydrates.
	%	%	%		%	%	%
Oysters,	6.2	1.2	3.7	Ice cream,	4.2	6.3	26.1
Soup (dinner),	5.2	0.9	2.8	Cake,	4.6	5.9	60.5
Celery,	1.4	0.1	3.0	Butter,	—	82.4	—
Fish,	19.2	1.0	—	Bread, rye,	10.1	0.7	55.9
Potatoes,	2.7	0.2	22.3	Cheese,	18.8	21.0	3.7
Oyster plant,	1.1	0.5	17.1	Water biscuit,	12.4	4.4	74.2
Green peas,	3.6	0.2	9.8	Beer,	0.5	—	2.7
Tomatoes,	1.2	0.2	4.0	Soup, vegetable,	2.9	—	0.5
Bread,	9.5	1.2	52.8	Veal,	20.8	9.9	—
Roast beef,	25.0	14.8	—	Bread pudding,	3.6	3.7	30.0
Chicken,	20.5	30.0	—				

* The Chemical Composition of American Food Materials (U. S. Dept. Agr., Office of Experiment Stations, Bulletin 28).

† Chemie d. menschlichen Nahrungs und Genussmittel, Vol. I.

TABLE 47.

Dietary No. 179. Food consumed in one day.

Date.	Food Consumed. (*Quantities in Ounces.*)	Nutrients. Protein.	Fat.	Carbo-hydrates.	Potential Energy.	Nutritive Ratio.
		Lbs.	Lbs.	Lbs.	Cal.	1:
Jan. 10. Dinner,	2 oysters, 10 soup, 1 celery, 3 fish, 1 potatoes, 2 oyster plant, 1 green peas, 1 tomatoes, 2 bread, 2 roast beef, 2½ chicken, 4 ice cream, 3 orange sherbet, ½ cakes, 1 butter, 11 wine (Burgundy),	.17	.14	.34	—	—
Supper,	8 roast beef, 7½ rye bread, 3½ Camembert cheese, 2 water biscuit, 3½ cakes, 4.4 lbs. beer,* - - -	.26	.14	.61	—	—
Jan. 11. Breakfast,†	9 vegetable soup, 2 potatoes, 3 veal (breaded chop), ½ green peas, 2 roast beef, 4½ bread pudding, ½ cakes, 14 beer, - - - -	.11	.05	.16	—	—
	Total in pounds, - -	.54	.33	1.11	4462	3.4
	Total in grams, - -	244	151	502	—	—

* Sandow sat a long time with friends after supper, and consumed a large part of the beer during this time.

† This was the regular lunch served at the hotel.

It will be seen that the heaviest meal was consumed very soon after the severe exercise. It is not claimed that the figures here given are perfectly accurate. The time of observation was very short and the diet was very varied. It would seem, however, from his own statements and from what we were able to observe, that the food of the day selected for the experiment was a fair average for Mr. Sandow's dietary habits. It is probable that the fat as computed is somewhat too high, since all the analyses of meat given in the standard tables refer to samples which contain visible fat, while, as noted above, Mr. Sandow rejected all the visible fat of the meat served him. It is, however, believed that no serious error was made in computing the composition of the food from tables rather than from analyses.

In the following table Sandow's dietary is compared with those of Weston, the foot-ball team, and the commonly accepted dietary standards for men at moderate and severe work:

TABLE 48.

Comparison of daily dietaries and dietary standards.

SUBJECT.	NUTRIENTS. Protein.	Fat.	Carbo-hydrates	Potential Energy.	Nutritive Ratio.
	Grams.	Grams.	Grams.	Cal.	1:
Sandow,	244	151	502	4462	3.4
Weston (walking),	83	—	—	—	—
Weston (after walking),	181	—	—	—	—
Foot-ball team per man,	181	292	557	5740	6.7
Man at moderate work (Voit),	118	56	500	3055	—
Man at moderate work (Atwater),	125	—	—	3500	5.8
Man at hard work (Voit),	145	100	450	3370	—
Man at hard work (Atwater),	150	—	—	4500	6.3

The total amount of food consumed is rather more than the average, though in his own opinion Mr. Sandow is not a large eater. This is in accord with the general conclusion reached in many investigations made with laboring men, that severe muscular exercise requires an abundant diet.

It will be seen that while the amount of carbohydrates and fat consumed does not differ very greatly from the standard for a man at muscular work, the amount of protein is very large and the nutritive ratio is very narrow.

The fact that so much protein is consumed is of especial interest. Zuntz* has advanced the opinion that the energy which is used in the production of severe muscular labor is furnished by the combustion of protein, while the energy for long continued, but not very severe, exercise is furnished by the combustion of carbohydrates or fat. The exercise performed by Mr. Sandow is very intense, and the large consumption of protein is in accord with Zuntz's theory.

* Experiment Station Record, VII., p. 538.

EXPERIMENTS ON THE DIGESTION OF FOOD BY MEN.

REPORTED BY W. O. ATWATER.

The Reports of this Station have contained accounts from time to time of digestion experiments with animals. The object of the present article is to describe the methods and results of experiments upon the digestion of different food materials by healthy men. As investigations of this particular kind are new in the United States a brief account of the purpose and plan of the experiments may be in place.*

The value of food for nutriment depends not only upon the amount of nutrients it contains, but also upon how much the body can digest and use for its support.

The question of the digestibility of food is very complex, and the current ideas regarding it are more or less indefinite and confused. One source of this confusion is the fact that what people commonly call the digestibility of food includes several very different things; some of which, as the ease with which a given food material is digested, the time required for the process, the influence of different substances and conditions upon digestion, and the effects upon comfort and health, are so dependent upon individual peculiarities of different persons, and so difficult of measurement, as to make the laying down of hard and fast rules impossible. Why it is, for instance, that some persons are made seriously ill by so wholesome a material as milk, and others find that certain kinds of meats or vegetables or sweetmeats "do not agree with them," it is difficult to explain. Late investigation, however, suggests the possibility that the ferments in the digestive canal or elsewhere may, with some people, cause particular compounds to be changed into injurious or even poisonous forms so that sometimes it may be literally true that "One man's meat is another man's poison."

* Detailed statements regarding the methods and results of inquiry in this direction may be found in Bulletin No. 21 of the Office of Experiment Stations of the United States Department of Agriculture on "Methods and Results of Investigations on the Chemistry and Economy of Food."

The digestion proper, by which we understand the changes which the food undergoes in the digestive canal in order to fit the digestible portion to be taken into the body and lymph and do its work as nutriment, is essentially a chemical process. About this a great deal has been learned within comparatively few years, although but comparatively little of the results has yet found its way into current literature.

The subject studied in the experiments here reported is a still different one. It has to do with the quantities of material actually digested from food as ordinarily eaten. The question is, What proportion of each of the nutrients in different food materials is actually digestible? In meat or bread, for instance, what percentages of the total protein, fats, and carbohydrates will be ordinarily digested by a healthy person, and what proportion of each will escape digestion?

The proportions of food constituents digested by domestic animals have been a matter of active investigation in European agricultural experiment stations during the past thirty years. During the past fifteen years not a little has been done in some stations in the United States. The experiments on digestion by sheep carried out by the Storrs Station belong to this class. The method consists in weighing and analyzing both the food consumed and the intestinal excretion. Since the latter represents very nearly the amount of food undigested, if we subtract it from the whole amount taken into the body the difference will be the amount digested.

Such experiments upon human subjects, however, are rendered much more difficult by the fact that in order that the digestibility of each particular food material may be determined with certainty, it must not be mixed with other materials. Hence the diet during the experiments must be so plain and simple as to make it extremely unpalatable. An ox will live contentedly on a diet of hay for an indefinite time, but for an ordinary man to subsist a week on meat or potatoes or eggs is a very different matter. No matter how palatable such a simple food may be, at first, to a man used to the ordinary diet of a well-to-do community, it will almost certainly become repugnant to him in a few days. In consequence, the digestive functions are disturbed and the accuracy of the trial impaired, a fact, by the way, which strikingly illustrates the importance of varied diet in civilized life.

Digestion experiments with men living on an ordinary mixed diet present no serious difficulty and it is fair to assume that the results may often be nearer approximations to the normal digestion than those of experiments with single food materials. The experiments here reported have been with single food materials and with mixed diet. Those with mixed diet are of the most consequence for the present report, not only because they apparently represent more nearly the digestibility of foods as ordinarily eaten, but because of the use made of them in a discussion in the article which follows.

In a compilation of the results of investigations of this sort made previous to 1895,* accounts were given of all the experiments which the writer and his associates found in the literature of the subject and which seemed accurate enough to be used for statistical inferences. Nearly all the experiments had been made in Europe; more had been made in Germany than in any other country. The total number of individual experiments included in the compilation was less than one hundred and fifty. Of this number 114 were with men, five with women, and 13 with children. It is evident, therefore, that the results thus far obtained are far from sufficient, and the desirability of further inquiry in this line is very clear. In connection with the investigations on the nutrition of man which are being carried out by the Department of Agriculture in Washington in coöperation with experiment stations and other institutions, quite a number of digestion experiments have already been made and others are in progress. There is reason to hope, therefore, that results of no little value will gradually accumulate.

EXPERIMENTAL METHODS FOLLOWED.

As the methods in common use for investigations of this sort have been described by the writer elsewhere,* a detailed description is hardly necessary here. It will suffice to say that in the experiments here reported the food and the feces were analyzed by the usual methods, and that the weights and composition of the materials are taken as showing the total amounts of nutrients in the food and the amounts left undigested in the feces. Subtracting the undigested residue from the total amount shows the amount actually digested.

* Bulletin 21 of the Office of Experiment Stations, pp 56–73.

This method involves two errors. One results from the imperfections of the current methods of chemical analysis, the other is due to the fact that the feces contain certain amounts of material other than undigested residue of the food—the so-called metabolic products. It is safe to assume, however, that the errors of analysis are not large. The metabolic products are mainly residues of the digestive juices, mucus, and the epithelium mechanically separated from the walls of the alimentary canal. While the quantities of these metabolic products are small they are, nevertheless, sufficient to make it desirable that allowance be made for them in accurate experimenting. No method has yet been devised for their exact determination, however, and it is customary not to take them into account but to regard them as belonging to the undigested residue of the food. As they represent material which is used for the purposes of digestion, and hence is not available to the body for the formation of tissue and the yielding of energy, this method of treating them as if they were undigested food involves practically no error so far as the value of the food for the principal purposes for which it is used, namely, to furnish the body with nourishment.

Experimenters employ various methods for distinguishing between the undigested residue of the food, the digestibility of which is being tested, and the residues from the food eaten before and after the experiment. The method here followed involves the use of milk and charcoal. For the meal immediately preceding the experiment—generally the supper of the day before the experiment begins—the subject drinks a moderate amount of milk. With this he takes a quantity of very finely divided charcoal, which is enclosed in gelatine capsules, and is easily swallowed. The feces from this milk have a consistency and color which makes it possible to separate them from those of the food which is taken for the succeeding meal. In the same way milk and charcoal are taken for the meal following the last one of the experiment. The separations by this method have proved quite satisfactory in our experience.

COEFFICIENTS OF DIGESTIBILITY.

The proportions of ingredients digested, when expressed in percentages, are commonly designated as coefficients of digestibility. Thus in experiment No. 4 (see table 49 beyond), the

subject received 463 grams of protein in the food, of which 11 grams were excreted by the intestine. This latter amount, which is here taken as representing the undigested protein, makes 2.4 per cent. of the total protein. Subtracting the 11 grams of undigested protein from the 463 grams of protein eaten, the remainder, 452 grams, makes 97.6 per cent. of the total. This is taken as the measure of the protein digested, and is thus the coefficient of digestibility of the protein in this experiment. By comparing the coefficients of digestibility, as found in a number of similar experiments, averages are obtained for general use.

Statements regarding the methods of estimating the fuel value are given on pages 177, 178.

THE DETAILS OF THE EXPERIMENTS.

The tables and descriptions which follow give accounts of fourteen individual experiments made with several different persons. The subject of Nos. 1–5 and 9–12, inclusive, was the laboratory janitor who acted as the subject of respiration experiments Nos. 1 and 2, above described. Experiment No. 6 was made with three chemists who ate together of the same food. As this experiment involves the measurement of the income and outgo of nitrogen, and was carried out with unusual care, it is treated by itself. The subject of Nos. 7 and 8 was an infant. The experiments are reported beyond by Mr. Bryant. The subjects of Nos. 13 and 14 were gentlemen engaged in experimental inquiry.

The results of experiments Nos. 1–5 and 9–14 are given in some detail in table 49. In connection with this are descriptions of the individual experiments.

TABLE 49.

DIGESTION EXPERIMENTS WITH MEN.

NOS. 1-5 AND 9-14.

Kinds, weights and composition of food materials and of undigested residues, with percentages of nutrients digested.

Food Materials.	Laboratory No.	Weight.	Percentage Composition.				Weights and Percentages Digested.				
			Protein.	Fat.	Carbo-hydrates.	Fuel Val. per Gram.	Organic Matter.	Protein.	Fat.	Carbo-hydrates.	Fuel Value.
Experiment No. 1.		Gms.	%	%	%	Cal.	Gms.	Gms.	Gms.	Gms.	Cal.
Milk, - - -	4143	4311	3.5	4.9	4.7	.842	564	151	211	202	3630
Milk, - - -	4144	2868	3.2	4.1	4.6	.767	341	91	119	131	2200
Total, - -	—	—	—	—	—	—	905	242	330	333	5830
Feces, - - -	573	118	24.3	9.0	44.1	6.003	91	29	10	52	710
Net am't digested,	—	—	—	—	—	—	814	213	320	281	4935
							%	%	%	%	%
Percent. digested,	—	—	—	—	—	—	90.0	88.1	97.0	84.4	87.8
Experiment No. 2.							Gms.	Gms.	Gms.	Gms.	Cal.
Milk, - - -	4146	4756	3.8	5.5	4.2	.915	641	181	262	198	4352
Milk, - - -	4147	4741	4.0	5.7	3.9	.953	643	190	269	184	4518
Milk, - - -	4148	3165	3.5	4.3	4.1	.812	380	113	137	130	2570
Total, - -	—	—	—	—	—	—	1664	484	668	512	11440
Feces, - - -	574	201	21.9	14.9	38.4	5.732	151	44	30	77	1215
Net am't digested,	—	—	—	—	—	—	1513	440	638	435	9842
							%	%	%	%	%
Percent. digested,	—	—	—	—	—	—	90.9	90.9	95.5	85.0	89.4
Experiment No. 3.							Gms.	Gms.	Gms.	Gms.	Cal.
Flour (as bread), -	575	1447	13.3	1.3	74.0	3.903	1282	193	18	1071	5648
Sugar, - - -	2722	201	—	—	100.0	3.987	201	—	—	201	801
Total, - -	—	—	—	—	—	—	1483	193	18	1272	6449
Feces, - - -	585	69	49.5	14.6	23.6	5.143	60	34	10	16	355
Net am't digested,	—	—	—	—	—	—	1423	159	8	1256	5956
							%	%	%	%	%
Percent. digested,	—	—	—	—	—	—	95.9	82.3	45.4	98.7	92.4
Experiment No. 4.							Gms.	Gms.	Gms.	Gms.	Cal.
Flour (as bread), -	575	1500	13.3	1.3	74.0	3.903	1329	200	19	1110	5854
Milk, - - -	4153	3496	3.8	5.9	4.9	1.007	510	133	206	171	3520
Milk, - - -	4154	3656	3.6	6.2	4.3	1.006	514	130	227	157	3678
Total, - -	—	—	—	—	—	—	2353	463	452	1438	13052
Feces, - - -	2503	45	24.8	10.6	36.3	5.282	32	11	5	16	238
Net am't digested,	—	—	—	—	—	—	2321	452	447	1422	12421
							%	%	%	%	%
Percent. digested,	—	—	—	—	—	—	98.6	97.6	98.9	98.9	95.2

DESCRIPTIONS OF INDIVIDUAL EXPERIMENTS.

Experiment No. 1.—Kind of food: Milk. *Subject:* Laboratory janitor. *Age:* 28 years. *Weight* (without clothing): 67.6 kilos (149 lbs.). The experiment commenced with breakfast, October 23, 1894, and ended with dinner, October 24, making 5 meals.

The charcoal for the separation of the feces was taken with the milk of the first meal, so that the colored feces were included in the amount collected for analysis. The second separation was made with milk and charcoal for the next meal after the end of the experiment, *i. e.*, for supper, October 24. The large weight of the feces suggests the idea that the first milk may flush the intestines so as to carry metabolic products or material with the feces which do not belong to the milk. This, if true, would account not only for the very large excretion, but also for the low digestibility of protein indicated. As a matter of fact, the excretion for the first day was very large, and for the remaining time, two-thirds of a day, very small. The subject experienced no discomfort from his diet and performed his duties about the laboratory as usual. Since the results do not appear to be entirely trustworthy, as indicating the proportions of nutrients digested, they are not included in the summary in table 53.

Experiment No. 2.—Kind of food: Milk. *Subject:* Same as in No. 1. *Weight* (without clothing): 67.6 kilos (149 lbs.). The experiment commenced with breakfast, October 29, 1894, and ended with dinner, October 31, making 8 meals. The separation of the feces was the same as in Experiment No. 1, and the same remarks apply.

Experiment No. 3.—Kind of food: Flour (as bread), and sugar. *Subject:* Same as in Nos. 1 and 2. *Weight* (without clothing): 67.6 kilos (149 lbs.). The experiment commenced with breakfast, November 6, 1894, and ended with dinner, November 8, making 8 meals. The separation of the feces was made by means of milk and charcoal taken as the last meal preceding the commencement and the first meal after the end of the experiment, *i. e.*, supper, November 5. and supper, November 8. The division was made so that none of the colored feces were included in the portion analyzed. This is the usual method of separation and was followed in all subsequent experiments. The flour was made into bread, for which 1447 grams were used, with salt and baking powder, but without fat for "shortening." The resulting bread weighed 2312 grams. This experiment is defective in that the loss of material during the process of baking is left out of account. Late experiments* indicate that the loss of fat in the baking of bread may be very considerable. For this reason, and because of the very small amount of fat present even in the uncooked flour, as well as the doubtful accuracy of fat determinations by the ordinary methods, especially in feces, the figures for the digestibility of the fat are not given.

Experiment No. 4.—Kind of food: Flour and milk. *Subject:* The same as in the preceding experiments. *Weight* (without clothing): 67.6 kilos (149 lbs.). The experiment commenced with breakfast, December 12, 1894, and ended with dinner, December 14, making 8 meals. The separation of the feces was made by milk and charcoal, as in experiment No. 3. Flour to the amount of 1500 grams was made into 2436 grams of bread, as in the preceding experiment. The statements regarding the fat in the bread apply here as in experiment No. 3, but inasmuch as the fat of the flour or bread is so small in amount as compared with that furnished by the milk, the figures for the amount of fat digested are no doubt reliable.

* See Bulletin No. 35, Office of Experiment Stations, United States Department of Agriculture, pp. 14 to 17.

TABLE 49.—*(Continued.)*

FOOD MATERIALS.	Laboratory No.	Weight.	PERCENTAGE COMPOSITION.				WEIGHTS AND PERCENTAGES DIGESTED.				
			Protein.	Fat.	Carbohydrates.	Fuel Val. per Gram.	Organic Matter.	Protein.	Fat.	Carbohydrates.	Fuel Value.
Experiment No. 5.		Gms.	%	%	%	Cal.	Gms.	Gms.	Gms.	Gms.	Cal.
Milk, - - -	4155	4647	4.2	5.6	4.4	.977	662	198	260	204	4540
Milk, - - -	4156	4051	3.8	5.8	3.9	.913	548	154	235	159	3698
Milk, - - -	4157	4658	4.0	3.6	4.7	.778	574	186	168	220	3624
Total, - -	—	—	—	—	—	—	1784	538	663	583	11862
Feces, - - -	2504	140	17.0	9.1	43.7	5.617	98	24	13	61	826
Net am't digested,	—	—	—	—	—	—	1686	514	650	522	10589
							%	%	%	%	%
Percent. digested,	—	—	—	—	—	—	94.5	95.6	98.1	89.5	89.3
Experiment No. 9.							Gms.	Gms.	Gms.	Gms.	Cal.
Bread, - -	2643	1548	8.4	.1	48.7	2.563	885	130	1	754	3968
Sugar, - -	2722	155	—	—	100.0	3.987	155	—	—	155	618
Total, - -	—	—	—	—	—	—	1040	130	1	909	4586
Feces, - - -	2644	27	38.7	16.6	21.6	5.345	21	11	4	5	144
Net am't digested,	—	—	—	—	—	—	1019	119	*	904	4338
							%	%	%	%	%
Percent. digested,	—	—	—	—	—	—	98.0	91.9	—	99.4	94.6
Experiment No. 10.							Gms.	Gms.	Gms.	Gms.	Cal.
Cooked beef, round,	2681	852	23.7	16.9	—	2.910	346	202	144	—	2479
Milk, - - -	4191	3300	3.4	4.3	5.0	.836	418	114	140	164	2759
Butter, - -	4210	175	.9	88.1	—	7.973	155	1	154	—	1395
Oatmeal, - -	2682	200	17.8	7.0	66.2	4.412	182	36	14	132	882
Bread, - -	2680	1865	9.6	.2	53.9	2.813	1187	179	3	1005	5246
Sugar, - -	—	184	—	—	100.0	3.987	184	—	—	184	734
Total, - -	—	—	—	—	—	—	2472	532	455	1485	13495
Feces, - - -	2763	93	31.8	16.5	24.5	5.085	68	30	15	23	473
Net am't digested,	—	—	—	—	—	—	2404	502	440	1462	12585
							%	%	%	%	%
Percent. digested,	—	—	—	—	—	—	97.3	94.4	96.7	98.5	93.3
Experiment No. 11.							Gms.	Gms.	Gms.	Gms.	Cal.
Beef, fried, - -	2696	604	29.0	9.8	1.0	2.494	240	175	59	6	1506
Eggs, boiled, -	2695	497	14.4	11.3	—	1.897	127	71	56	—	1061
Butter, - -	4238	175	.9	86.3	—	8.122	153	2	151	—	1421
Cheese, - -	4228	300	26.8	24.5	1.2	4.219	158	80	74	4	1266
Milk, - - -	4227	4400	3.6	4.2	5.4	.836	582	159	183	240	3678
Crackers, - -	2697	396	5.5	12.3	75.2	4.679	368	22	48	298	1852
Bread, - -	2693	1250	9.2	.2	50.3	2.681	746	115	2	629	3351
Potatoes, boiled, -	2694	755	2.2	.1	16.2	.787	140	17	1	122	594
Sugar, - -	2722	100	—	—	100.0	3.987	100	—	—	100	399
Total, - -	—	—	—	—	—	—	2614	641	574	1399	15128
Feces, - - -	2764	102	25.9	14.6	28.9	4.903	71	26	15	30	500
Net am't digested,	—	—	—	—	—	—	2543	615	559	1369	14093
							%	%	%	%	%
Percent. digested,	—	—	—	—	—	—	97.3	95.9	97.4	97.9	93.2

* See description of experiment on opposite page.

Experiment No. 5.—Kind of food: Milk. *Subject:* The same as in the preceding experiment. *Weight* (without clothing): 67.1 kilos (148 lbs.), at the beginning, and 65.8 kilos (145 lbs.), at the end of the experiment. The experiment commenced with breakfast, December 19, 1896, and ended with supper, December 21, making 9 meals. The separation of the feces was made with milk and charcoal in the usual manner.

Experiment No. 9.—Kind of food: Bread and sugar. *Subject:* Laboratory janitor as in the preceding experiments. *Weight* (without clothing): 67.6 kilos (149 lbs.). The experiment commenced with breakfast, September 16, 1895, and ended with supper, September 17, making 6 meals. The separation of the feces was made as above, but was not as well defined as usual. The milk and charcoal feces from the supper of September 15 appeared partly on September 17 and the remainder September 18. Grape seeds from grapes eaten on the evening of September 14 were scattered through the milk and charcoal feces and a few were in the feces from the bread and sugar. To learn whether this lag in the passage of the grape seeds through the intestine was normal, grapes were eaten heartily for dinner, September 20, the seeds being swallowed. Supper consisted of milk and the following breakfast of bread. The grape seeds were scattered through the feces of the milk, of the bread and of the food next following the bread.

This experiment is practically a repetition of No. 3, except that in this instance the bread was analyzed, while in the former the flour from which the bread was made was analyzed. It will be observed that the amount of ether extract in the feces was larger than that in the bread, though the quantities in both were small. These results illustrate very forcefully the difficulty of accurate estimates of digestibility of fats by the current methods.

Experiment No. 10.—Kind of food: Mixed diet. *Subject:* Same as in the preceding experiments. *Weight* (without clothing): 67.1 kilos (148 lbs.). The experiment commenced with breakfast, January 28, 1896, and ended with dinner, January 31, making eleven meals. This experiment, with what may be called a mixed diet, represents more nearly normal conditions in this respect than any of the previous ones. The results would seem on this account to be more trustworthy as representing the digestibility of the nutrients in an ordinary diet. Accordingly the data of this experiment are used with those of Nos. 6, 11, 12, 13 and 14, which were also with mixed diet, for the computations of table 53, beyond.

Experiment No. 11.—Kind of food: Mixed diet. *Subject*: The same as in the preceding experiment. *Weight* (without clothing): 66.9 kilos (147½ lbs.). The experiment commenced with breakfast, February 15, 1896, and ended with dinner, February 19, making 14 meals, of which the last seven were taken in the respiration apparatus as respiration experiment No. 1, previously described. The cheese in the experiment was not burned in the bomb calorimeter, as the sample had decomposed before the combustion could be made. The heat of combustion was estimated from the values obtained from a similar cheese. The beef was round steak chopped fine in a meat cutter and mixed with a little onion and fried. The crackers were ordinary "milk crackers." The bread was made of rye and wheat flour and was such as the subject was accustomed to eat at home.

TABLE 49.—*(Concluded.)*

FOOD MATERIALS.	Laboratory No.	Weight.	Percentage Composition. Protein.	Fat.	Carbohydrates.	Fuel Val. per Gram.	Weights and Percentages Digested. Organic Matter.	Protein.	Fat.	Carbohydrates.	Fuel Value.
Experim't No. 12.		Gms.	%	%	%	Cal.	Gms.	Gms.	Gms.	Gms.	Cal.
Beef, fried, -	2699	515	31.1	11.1	—	2.788	217	160	57	—	1436
Eggs, boiled, -	2698	498	13.6	13.0	—	2.043	133	68	65	—	1142
Butter, - -	4239	175	1.0	85.4	—	8.184	151	2	149	—	1432
Cheese, - -	4237	300	25.4	27.0	4.0	4.294	169	76	81	12	1266
Milk, - -	4240	2400	3.4	4.5	5.5	.822	321	81	108	132	1973
Crackers, - -	2701	400	10.4	12.2	69.3	4.679	368	42	49	277	1872
Rye bread, -	2703	1136	9.0	.2	49.0	2.607	661	102	2	557	2961
Potatoes, boiled,	2700	661	4.5	.1	17.5	.965	146	30	1	115	638
Sugar, - -	2722	180	—	—	100.0	3.987	180	—	—	180	718
Total, - -	—	—	—	—	—	—	2346	561	512	1273	13438
Feces, - -	2765	111	41.6	13.3	18.0	4.886	81	46	15	20	542
Net am't digested,	—	—	—	—	—	—	2265	515	497	1253	12446
							%	%	%	%	%
Percent. digested,	—	—	—	—	—	—	96.6	91.8	97.1	98.4	92.6
Experim't No. 13.							Gms.	Gms.	Gms.	Gms.	Cal.
Beef, fried, -	2704	766	29.6	8.1	—	2.424	289	227	62	—	1857
Eggs, boiled, -	2705	904	22.0	17.6	—	2.937	358	199	159	—	2655
Butter, - -	4248	170	.8	88.4	—	8.435	152	2	150	—	1434
Milk, - -	4247	5380	3.3	4.5	5.5	.807	717	178	245	294	4341
Potatoes, boiled,	2708	2300	2.3	.1	21.7	1.032	554	52	3	499	2373
Bread, - -	2724	2275	8.2	1.3	50.6	2.735	1367	187	30	1150	6222
Apples, - -	2709	755	.2	.2	12.7	.547	99	2	1	96	413
Peaches, - -	2707	1400	.6	.1	9.7	.476	146	8	2	136	666
Pears, - -	2706	1400	.2	.1	19.5	.801	277	3	1	273	1121
Sugar, - -	2722	400	—	—	100.0	3.987	400	—	—	400	1595
Total, - -	—	—	—	—	—	—	4359	858	653	2848	22677
Feces, - -	2760	131	33.4	15.5	24.9	4.796	97	44	20	33	628
Net am't digested,	—	—	—	—	—	—	4262	814	633	2815	21341
							%	%	%	%	%
Percent. digested,	—	—	—	—	—	—	97.8	94.9	96.9	98.9	94.1
Experim't No. 14.							Gms.	Gms.	Gms.	Gms.	Cal.
Beef, fried, -	2715	1654	34.1	10.4	—	2.904	736	564	172	—	4803
Butter, - -	4249	765	1.1	86.9	—	8.169	673	8	665	—	6249
Milk, - -	4250	10600	3.3	4.2	5.6	.798	1384	351	445	588	8459
White bread, -	2727	2550	9.2	1.4	52.8	2.892	1616	235	35	1346	7375
Brown bread, -	2726	4000	5.8	1.1	43.6	2.305	2022	232	46	1744	9220
Oatmeal, - -	2723	680	17.2	7.0	65.3	4.409	609	117	48	444	2998
Beans, - -	2728	2040	6.9	.4	18.0	1.179	516	141	7	368	2405
Potatoes, boiled,	2725	1700	2.5	.1	20.6	.989	393	42	1	350	1681
Apples, - -	2709	2125	.2	.2	12.7	.547	279	5	4	270	1162
Sugar, - -	2722	340	—	—	100.0	3.987	340	—	—	340	1356
Total, - -	—	—	—	—	—	—	8568	1695	1423	5450	45708
Feces, - -	2761	432	34.1	13.4	29.0	4.723	330	147	58	125	2049
Net am't digested,	—	—	—	—	—	—	8238	1548	1365	5325	42317
							%	%	%	%	%
Percent. digested,	—	—	—	—	—	—	96.2	91.3	95.9	97.7	96.9

Experiment No. 12.—Kind of food: Mixed diet. *Subject:* The same as in the preceding experiments. *Weight* (without clothing): 67.4 kilos (148½ lbs.). The experiment commenced with breakfast, February 24, 1896, and ended with dinner, February 28, making 14 meals, of which the last 7 were taken in the respiration calorimeter as respiration experiment No. 2, previously described. The meat was prepared as in experiment No. 11, and the diet was the same in kind, the chief difference being that only about half as much milk was taken in this experiment as in No. 11.

Experiment No. 13.—Kind of food: Mixed diet. *Subject:* Chemist, 23 years old. *Weight* (without clothing): 63.6 kilos (140 lbs.). The experiment began with breakfast, March 13, 1896, and ended with breakfast, March 21, making 25 meals, of which the last 15 were taken in the respiration calorimeter as respiration experiment No. 3. The meat was chopped and fried as in experiments 11 and 12, but without the addition of onions.

Experiment No. 14.—Subject: Physicist, 22 years old. *Weight* (without clothing): 76.2 kilos (168 lbs.). The experiment began with breakfast, March 19, 1896, and ended with dinner, April 4, making 50 meals, of which the last 36 were taken in the respiration calorimeter as respiration experiment No. 4. The meat was prepared as in the previous experiment by chopping finely with a meat chopper and then frying, the sample for analysis being taken at the same time.

DIGESTION AND METABOLISM EXPERIMENT WITH THREE CHEMISTS.

Experiment No. 6 was carried out in 1894 by Messrs. R. L. Slagle, Ph. D., H. Monmouth Smith and H. A. Torrey, chemists at that time engaged in nutrition investigations in this laboratory. · The results so far as regards the consumption of food were published in the Report of the Station for 1894 (p. 194) as dietary No. 20. The object, however, was not simply to make this a dietary study, but also a digestion experiment with determinations of the income and outgo of nitrogen.

Inasmuch as part of the results of this experiment were given in the Report of the Station for 1894, as above stated, only such details are cited here as are necessary to the understanding of the investigation as an experiment upon the digestion of the food materials and the metabolism of nitrogen.

The subjects were engaged in their ordinary duties about the laboratory, and in addition to the exercise belonging to their regular work they were accustomed to walk considerable distances after their day's work was finished.

In the conduct of the experiment special care was observed. The gentlemen boarded together and sat at the same table. By the kindness of the mistress of the house, who took a very intelligent interest in the investigation, arrangements were made by which the food of the three gentlemen during the period

of the experiment was kept apart, cooked by itself and served at a separate table. One of the gentlemen was at hand to make weighings and take samples of each food material used. The securing of satisfactory samples of most of the food materials, such as bread, potatoes, milk, sugar, etc., was by no means a difficult matter. With meats, however, accurate sampling was far from easy. In order to insure accuracy in the present instance the meats were treated in a special way. Each portion was carefully separated from the bone and finely chopped. This finely chopped material was set aside, carefully preserved and cooked. A portion, however, was taken to the laboratory for analysis. Especial effort was made by this and other means to make sure that the samples of the different food materials should represent as closely as possible the food as it was actually cooked and eaten. The separations of feces were made by the method above described. The urine of each day was collected, measured, and portions were taken for the determination of the nitrogen by the Kjeldahl method. The further details are given in the descriptions which accompany the tabular statements of results.

Experiment No. 6.—Kind of food: Mixed diet. *Subject:* Three chemists, aged 23, 26 and 28 years. *Weight* (without clothing): At the beginning, 61.7, 60.3 and 68 kilos (136, 133 and 150 lbs.), and at the end, 63.5, 60.3 and 68 kilos, respectively. The experiment began with breakfast, October 10th, 1894, and ended with supper, October 19th, making 30 meals for each man.

With the exceptions noted below all the food materials were analyzed and their heats of combustion were determined by the bomb calorimeter. The fuel values of the milk and cream were not determined, but were calculated from the percentage composition by the use of the factors 5.5, 9.3 and 4.1 for the fuel values of one gram each of protein, fats and carbohydrates respectively. The crackers and apples were not analyzed, but the composition was assumed from averages of the analyses of similar food materials as given in Bulletin No. 28 of the Office of Experiment Stations of the U. S. Department of Agriculture on the "Composition of American Food Materials." The fuel values of these last named food materials were calculated by the use of the factors just referred to as employed for milk and cream. With the exception of the determinations of fuel values of the milk and cream, and the analyses and determinations of the fuel values of the crackers and apples, all of the food materials were analyzed for the purposes of the experiment and the heats of combustion were determined by the bomb calorimeter.

It should be added that the figures for protein given in the table for all the animal foods, except oysters, cheese, milk and cream, are as obtained by difference. For the animal foods just mentioned and the vegetable foods the protein is obtained by multiplying the nitrogen by the factor 6.25.

The weights and composition of the food materials and feces, and the proportions of food materials digested, are given in table 50. Table 51 gives the amounts of urine for each day and its nitrogen content, together with the weight and nitrogen content of the dried feces for the whole experiment. Table 52 shows the income and outgo of nitrogen for each day covered by the experiment, together with the estimated gain or loss of protein. The computations for these tables are made as explained in the corresponding tables in the accounts of the respiration experiments above.

TABLE 50.

DIGESTION EXPERIMENT No. 6.

Weights and composition of food materials and feces. Proportions of nutrients digested.

FOOD MATERIALS.	Laboratory No.	Percent. of Nitrogen.	Heats of Combustion per Gram.	TOTAL QUANTITIES. Weights of Materials.	Nitrogen.	Organic Matter.	Nutrients. Protein.	Fat.	Carbohydrates.	Fuel Value as Determined.
Beef.		%	Cal.	Gms.	Grams.	Gms.	Gms.	Gms.	Gms.	Cal.
Rib roast, - -	540	2.74	2.208	765	20.96	199	130	69	—	1690
Rib roast, - -	555	2.81	2.038	1035	29.08	265	177	88	—	2110
Rib roast, - -	566	2.27	2.058	565	12.83	112	74	38	—	1165
Shoulder steak, -	567	2.31	2.306	345	7.97	109	59	50	—	795
Shoulder steak, -	562	2.61	2.023	480	12.53	108	74	34	—	970
Shoulder steak, -	539	2.45	1.911	355	8.70	74	53	21	—	680
Shoulder steak, -	570	2.60	1.853	495	12.87	108	80	28	—	915
Corned, canned, -	541	4.42	3.120	470	20.77	209	132	77	—	1465
Cottolene, - -	552	—	9.561	905	—	905	—	905	—	8655
Veal rib, - -	542	2.46	1.462	865	21.28	154	132	22	—	1265
Veal rib, - -	565	2.41	1.731	640	15.42	101	79	22	—	1110
Smoked ham, -	553	2.96	3.384	355	10.51	146	67	79	—	1200
Smoked ham, -	538	2.67	2.643	270	7.21	85	46	39	—	715
Smoked ham, -	569	2.77	3.040	200	5.54	72	35	37	—	610
Salt pork, - -	561	.28	8.135	255	.71	245	5	240	—	2075
Fresh cod, - -	554	2.71	1.122	665	18.02	115	112	3	—	745
Oysters, solids, -	563	.98	.521	525	5.15	47	32	5	10	275
Eggs, - - - -	568	2.06	2.019	1390	28.63	379	215	164	—	2805
Butter, - - -	4145	.11	7.848	2280	2.51	1936	16	1920	—	17895
Cheese, - - -	543	3.82	4.463	510	19.48	321	122	154	45	2275
Milk, - - - -	4141	.53	.823	8435	44.71	1105	278	388	439	6940
Cream, - - -	4142	.50	1.864	1490	7.45	344	46	250	48	2775
Corn meal, - -	545	1.41	4.033	765	10.79	693	67	12	614	3085
Flour, bread, -	549	2.14	3.968	4565	97.67	4059	612	50	3397	18105
Flour, pastry, -	550	1.86	3.945	1885	35.06	1640	219	17	1404	7435
Oat meal, - -	551	2.93	4.583	1090	31.94	998	199	79	720	4995
Macaroni, - -	544	2.30	4.076	395	9.09	350	57	4	289	1610
Milk crackers,* -	—	1.49	4.567	555	8.27	509	52	73	384	2535
Tapioca, - - -	547	.05	3.718	130	.07	115	—	—	115	485
Sugar, - - - -	2270	—	3.987	4255	—	4255	—	—	4255	16965
Beans, dried, -	548	3.81	4.015	695	26.48	587	165	13	409	2790
Potatoes, flesh, -	559	.38	.840	6415	24.38	1244	154	6	1084	5390
Squash, flesh, -	564	.19	.552	1760	3.34	218	21	14	183	970
Swt. potatoes, flesh,	556	.14	1.257	7555	10.58	2251	68	23	2160	9495
Turnips, flesh, -	557	.16	.304	2950	4.72	198	30	12	156	895
Apples, flesh,* -	—	.08	.755	4960	3.97	873	25	25	823	3745
Cocoanut, dried, -	546	1.04	6.982	45	.47	43	3	29	11	315
Total, - -	—	—	—	—	579.16	25172	3636	4990	16546	137945
Waste, - - -	571	2.70	5.295	965	26.06	885	163	245	477	5110
Total food eaten,	—	—	—	—	553.10	24287	3473	4745	16069	132835
Feces, - - -	572	5.95	5.337	833	—	625	310	179	136	4445
Amount digested,	—	—	—	—	—	23662	3163	4566	15933	128390
Fuel value urea, -	—	—	—	—	—	—	—	—	—	2750
Net fuel value of food eaten, -	—	—	—	—	—	—	—	—	—	125640
Percent. digested,	—	—	—	—	—	97.4	91.1	96.2	99.2	94.6

* Not analyzed. Composition assumed as stated in explanation on page 174.

TABLE 51.

Weight of nitrogen in the urine of each day and the total weight of nitrogen in the feces for 10 days.

	Lab. No.	Weight of Urine.	Percent. Nitrogen.	Weight of Nitrogen.		Lab. No.	Weight of Urine.	Percent. Nitrogen.	Weight of Nitrogen.
		Gms.	%	Gms.			Gms.	%	Gms.
Urine, - -	5002	4029	1.31	52.78	Urine, - -	5010	3327	.91	30.28
Urine, - -	5003	4673	.87	40.66	Urine, - -	5011	3993	.55	21.96
Urine, - -	5004	3858	.88	33.95					
Urine, - -	5005	4549	.73	33.21	Total, - -	—	—	—	358.34
Urine, - -	5006	3695	.99	36.58	Feces, - -	572	833	5.95	49.56
Urine, - -	5007	3170	1.17	37.09					
Urine, - -	5008	3791	1.01	38.29	Total outgo of urine & feces,	—	—	—	407.90
Urine, - -	5009	2891	1.16	33.54					

TABLE 52.

Balance of income and outgo of nitrogen in digestion experiment No. 6, with three chemists.

Date.	Income.		Outgo.			
	Nitrogen in Food.	Nitrogen in Feces.	Nitrogen in Urine.	Total.	Nitrogen Gained (+) or Lost (−).	Protein Gained (+) or Lost (−).
	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
October 12, - - -	55.3	4.9	52.8	57.7	— 2.4	— 15
October 13, - - -	55.3	5.0	40.6	45.6	+ 9.7	+ 61
October 14, - - -	55.3	4.9	33.9	38.8	+16.5	+103
October 15, - - -	55.3	5.0	33.2	38.2	+17.1	+107
October 16, - - -	55.3	4.9	36.6	41.5	+13.8	+ 86
October 17, - - -	55.3	5.0	37.1	42.1	+13.2	+ 82
October 18, - - -	55.3	4.9	38.3	43.2	+12.1	+ 76
October 19, - - -	55.3	5.0	33.5	38.5	+16.8	+105
October 20, - - -	55.3	5.0	30.3	35.3	+20.0	+125
October 21, - - -	55.3	5.0	22.0	27.0	+28.3	+177
Total, - - -	553.0	49.6	358.3	407.9	+145.1	+907

It will be noticed that protein was stored constantly during the experiment, showing that the dietary furnished more of total nutrients and of nitrogenous material than was necessary for nitrogen equilibrium under the circumstances.

The amounts of food eaten varied from day to day in accordance with the inclinations of the subjects of the experiments. This doubtless explains in large part the daily variations in the nitrogen excretion.

This experiment is of interest because of the unusual care and thoroughness with which the details were carried out by the gentlemen who joined in the work; because it gives a very accurate measure of the digestibility of the nutrients of an ordinary mixed diet under normal condition, and because it adds to the list of accurate observations upon the actual food consumption of typical persons.

COMMENTS UPON THE TABLES.

Some of the data above tabulated call for a few words of explanation before we proceed to the summarizing of the results.

Fuel values.—The fuel values of the digested food may be estimated either from the heats of combustion as found by determinations with the bomb calorimeter or by the use of factors such as those of Rübner. The latter, as commonly used, apply to total rather than digestible nutrients and ascribe 4.1 calories to each gram of protein or carbohydrates and 9.3 calories to each gram of fats.

In the experiments here reported the heats of combustion of both food and feces were determined by direct combustion with oxygen in the bomb calorimeter. In experiments 11–14 inclusive the heats of combustion of the dried residue of the urine were determined in like manner.

It is hoped that a somewhat detailed discussion of the methods of estimating fuel values from the heats of combustion may be given in another place. Meanwhile it will suffice to explain briefly the methods of computation used for the preceding tables.

Net fuel value of food digested.—By subtracting the heat of combustion of the feces from that of the total food eaten we obtain the total heat of combustion of the food digested. This, however, does not represent the actual fuel value. In the first place it is not positively proved that the energy liberated and used in the body is exactly the same as that developed in the form of heat by combustion with oxygen in the calorimeter. It is common, however, to assume that such is the case. Even on this assumption the fuel value of the digested food will not be exactly the heat of combustion because not all of the digested food is completely consumed in the body. Leaving out of account the material which is either

stored in the body when the food is in excess of its demands, or consumed from the previous supply in the body when the digested food is not equal to the demands of the latter, there still remains a certain quantity of nitrogenous material which is not completely oxidized but is eliminated by the kidneys in urea and allied compounds. Assuming that all of the digested nitrogen excreted from the body is in the form of urea, we may roughly calculate the amount of the potential energy of protein which thus fails to be transformed into kinetic energy in the body.

Urea contains 46.67 per cent. N., hence N. $\times$ 2.143 = urea. N. $\times$ 6.25 = protein. Hence protein divided by 6.25 $\times$ 2.143 = the urea corresponding to the protein. The heat of combustion of one gram of urea is 2.53 calories. The fuel value of the urea corresponding to one gram of protein would therefore be 1 (gram of protein) $\div$ 6.25 $\times$ 2.143 $\times$ 2.53, or 0.87 calories.*

According to this computation, which is theoretical and but approximately correct, there would be for each gram of digested protein 0.87 calories of energy in the unconsumed urea and other compounds. Subtracting this value from the total fuel value of the digested nutrients the remainder may be assumed to represent the proportion of the total energy of the digested nutrients which becomes actually available to the body. This is designated in the tables as "net fuel value of the food digested." In estimating the coefficients of digestibility for the fuel values this net fuel value is used rather than the total fuel value of the digested nutrients.

SUMMARY OF RESULTS OF DIGESTION EXPERIMENTS.

The results of the experiments as expressed in the quantities of nutrients in the food eaten and the coefficients of digestibility are recapitulated in table 53. In this table it will be observed that experiments 1–5 and 9–12 were made with the laboratory janitor, who was used to moderately hard muscular work, while the subjects of Nos. 13 and 14 were assistants in the laboratory, whose ordinary labor involves somewhat less of muscular exercise. In experiments 11, 12, 13 and 14, however, the subjects were in the respiration apparatus and without muscular

* For further explanations of this matter see Report of this Station, 1894, pp. 125, 126.

exercise, except for a period of three days in experiment No. 14, when the muscular exercise was quite active, as explained above in the account of respiration experiment No. 4, which was part of digestion experiment No. 14. There is no reason for assuming, however, that the coefficients of digestibility of the food were materially affected by the muscular activity.

TABLE 53.

Amounts per day and percentages of nutrients digested (coefficients of digestibility) in experiments above detailed.

Number of Expt.	Subjects and Food Materials.	Protein. Grams.	Protein. Per Cent.	Fat. Grams.	Fat. Per Cent.	Carbohydrates. Grams.	Carbohydrates. Per Cent.	Fuel Value. Calories.	Fuel Value. Per Cent.
	E. O., Laboratory Janitor.								
1	Milk,	128	88.1	192	97.0	168	84.4	2960	87.8
2	Milk,	165	90.9	239	95.5	163	85.0	3690	89.4
3	Wheat bread,	59	82.3	(?)	(?)	471	98.7	2235	92.4
4	Bread and milk,	169	97.6	168	98.9	533	98.9	4660	95.2
5	Milk,	171	95.6	217	98.1	174	89.5	3530	89.3
	Three Chemists.								
6	Mixed diet (see table 50),	105	91.1	152	96.2	531	99.2	4190	94.6
	E. O., Laboratory Janitor.								
9	Wheat bread,	60	91.9	(?)	(?)	452	99.4	2170	94.6
10	Beef round, milk, butter, oatmeal, bread, sugar,	137	94.4	120	96.7	399	98.5	3430	93.3
11	Beef round, eggs, butter, cheese, milk, crackers, bread, potatoes, sugar,	132	95.9	120	97.4	293	97.9	3020	93.2
12	Same diet as No. 11,	111	91.8	107	97.1	268	98.4	2665	92.6
	O. F. T., Chemist.								
13	Beef round, eggs, butter, milk, bread, potatoes, apples, peaches, pears, sugar,	98	94.9	76	96.9	338	98.9	2560	94.1
	A. W. S., Physicist.								
14	Beef round, butter, milk, white bread, brown bread, oatmeal, beans, potatoes, apples, sugar,	93	91.3	82	95.9	320	97.7	2540	96.9

The results of experiments 1, 2 and 3 are not entirely reliable indications of the actual digestibility of milk and bread as ordinarily eaten, partly because of defects in the experiments themselves, which were indicated above, and partly because of

the probability that these materials, taken by themselves, are not digested as completely as when they form a part of a mixed diet.

With reference to the figures of table 53, it should be observed that the results are subject to the errors inherent in experiments made by the current methods as above stated. The principal sources of error are probably three: *(a)* defects in the ordinary methods of analysis; *(b)* failure to make allowance for metabolic products, which are here considered as belonging to the undigested residue of the food, though they actually represent material which has been digested; *(c)* variations due to individuality of the subject and other influences not well understood. The error due to imperfections of analysis, while important, is probably not large. The error from treating the metabolic products in the feces as if they were a part of the undigested residue of the food, is small and of theoretical rather than practical interest so far as concerns the nutriment actually obtained from the food. The variations in digestion of the same food by different persons may be more or less considerable. As regards the variations of digestion of food by the same person under different conditions, the results of inquiry up to the present time lead to the inference that while the digestive apparatus of the subject is in normal condition, and the quantities of food are also normal, the coefficients of digestibility are much less affected by exercise or rest than is commonly supposed. There does seem to be ground, however, for the belief that in ordinary mixed diet the digestion is generally more complete than where only a single food material is eaten.

TWO DIGESTION EXPERIMENTS WITH AN INFANT.

BY A. P. BRYANT.

During the winter of 1895 two digestion experiments were made with a child nine to ten months old, in order to ascertain the amounts of nutrients consumed and digested per day with their fuel values. The first study, in February, was of eight days; the second, in March, of nine days' duration.

The subject.—The child, a boy, was a few days more than nine months old at the time of the first experiment. He was strong and healthy, weighing, at the beginning of the study, twenty-five pounds three ounces (11.43 kilos). His appetite, though at times variable, was, as a rule, hearty. He neither crept nor walked at this time. The second experiment began exactly one month later, at which time the child was learning to walk, and moved around a little by holding on to objects.

Food.—At the time of the first study the child lived entirely upon one cow's milk. During the second study a thin oatmeal gruel was mixed with the milk. This gruel was made by thinning oatmeal after cooking till, while warm, it was nearly the consistency of milk, and then passing it through a moderately fine strainer to remove lumps and coarse particles.

Each day a certain definite proportion of the milk, one cubic centimeter to the ounce (about one part in twenty-eight) was taken for analysis. These daily portions were made into a composite sample and preserved, by means of a very small amount of corrosive sublimate, until the analysis could be made. Each time the oatmeal gruel was prepared one-half was taken for analysis. The proportions of milk and oatmeal as fed in the second experiment were about four to one by volume.

Undigested residue.—In order to ascertain how much of the nutrients of the food eaten are actually absorbed, and thus utilized in the body, it is necessary to determine the amount of

undigested nutrients rejected in the feces. In digestion experiments with adults powdered charcoal can be taken at the beginning and at the end of the experimental period, as described above on page 166, and thus the exact amount of the feces which came from the food consumed during the experiment can be determined and collected for analysis. This method was impracticable in the present case, and it was assumed that the undigested residue from the food of a given day would be excreted in the feces of the following day.

Inasmuch as for some time preceding each study the daily food consumed was practically identical in kind and amount with that consumed during the experiment, any error from this assumption would probably be slight.

Composition of the food.—The food and feces were analyzed, and the heats of combustion were determined by the bomb calorimeter. The results are shown herewith.

TABLE 54.

Percentages of nutrients in the foods used in two digestion experiments with an infant, and in the feces, together with fuel values per gram as determined by the bomb calorimeter.

FOOD MATERIALS.	Lab. Number.	Water.	Protein.	Fat.	Carbohydrates.	Ash.	Fuel Value per Gram Determined.
		%	%	%	%	%	Calories
Milk, 1st experiment,	4160	85.37	4.38	5.43	4.00	.82	.969
Milk, 2d experiment,	4162	86.20	3.94	4.47	4.62	.77	.876
Oatmeal gruel,	2535	95.69	.87	.18	2.94	.32	.188
Sugar,	2722	—	—	—	100.00	—	3.987
Feces, 1st experiment,	2519	5.14	16.38	14.08	40.39	24.01	5.915
Feces, 2d experiment,	2534	4.95	18.50	7.03	37.85	31.67	4.935

The results.—At the time of the first experiment the child was receiving milk alone. Oatmeal gruel and rice gruel had been given previously with the milk, but had for a time been discontinued. It was observed that in this experiment the milk was not thoroughly digested at all times; undigested curds frequently appeared in the feces. The child's appetite was also variable, the amount of milk taken per day varying from 33 to 50 ounces (935 to 1420 grams).

Shortly after the close of this study the child took cold and lost his appetite. This accounts for the fact that at the beginning of the second study he weighed less by over three-quarters of a pound than at the close of the first experiment.

At the time of the second experiment oatmeal gruel was added to the milk, as described above, in order to ascertain if the mixed food would be more digestible than the milk alone. This apparently was the case. The feces contained fewer undigested curds and the child's appetite was more constant. Of the protein two per cent. more was digested in the second experiment than in the first, and 1.7 per cent. more fat. The greatest difference, however, appears in the carbohydrates, where we find an increase of ten per cent. in the digestibility of the milk and oatmeal together, as compared with that of the milk alone.

DIGESTION EXPERIMENT NO. 7.

Kinds of food: Milk. *Subject:* Infant, 9 months old; weight, without clothing, 25.19 lbs. (11.43 kilos), at the beginning, and 25.38 lbs. (11.51 kilos), at the end of the experiment. *Sex:* Male. The experiment began with the first meal taken February 5, 1895, and continued 8 days, ending with the last meal taken February 12. Six meals a day were usually taken. The feces were collected from the morning of February 6 to the morning of February 14 (8 days).

TABLE 55.

Weights and fuel values of nutrients in food eaten and in feces for 8 days; and weights, fuel values, and percentages of nutrients digested.

MATERIALS.	Weight of Material.	Total Organic Matter.	Protein.	Fat.	Carbohydrates.	Ash.	Fuel Value Determined.
	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Calories
Milk (cow's),	9752	1347	427	530	390	80	9450
Feces, *i. e.*, undigested residue,	161	114	26	23	65	39	950
Amount digested,	—	1233	401	507	325	41	8500
Fuel value of urea,*	—	—	—	—	—	—	350
Net fuel value food digested,	—	—	—	—	—	—	8150
	%	%	%	%	%	%	%
Percent. digested,	—	91.5	93.8	95.7	83.3	51.6	86.3

* Digested protein multiplied by .87. See explanations p. 178.

DIGESTION EXPERIMENT NO. 8.

Kinds of food: Milk, oatmeal, and sugar. *Subject:* Infant, 10 months old; same child as No. 7; weight, without clothing, 24.56 lbs. (11.14 kilos), at the beginning, and 25.60 lbs. (11.61 kilos), at the end of the experiment. The study began with the first meal eaten March 5, 1895, and continued 9 days, ending with the last meal eaten March 13. Six meals a day were usually taken. The feces were collected from the morning of March 6 to the morning of March 15 (9 days).

TABLE 56.

Weights and fuel values of nutrients in food eaten and in feces for 9 days; and weights, fuel values, and percentages of nutrients digested.

FOOD MATERIALS.	Weight of Material.	Total Organic Matter.	Protein.	Fat.	Carbohydrates.	Ash.	Fuel Value Determined.
	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Cal.
Milk (cow's), - - - -	10120	1319	399	452	468	78	8865
Oatmeal, - - - - -	2722	109	24	5	80	9	505
Sugar, - - - - -	100	100	—	—	100	—	400
Total, - - - -	12942	1528	423	457	648	87	9770
Feces, *i. e.*, undigested residue, - - - -	107	68	20	7	41	34	530
Amount digested, - -	—	1460	403	450	607	53	9240
Fuel value of urea,* -	—	—	—	—	—	—	350
Net fuel value food digested,	—	—	—	—	—	—	8890
	%	%	%	%	%	%	%
Percent. digested, - -	—	95.6	95.3	98.4	93.7	60.9	91.0

* Digested protein multiplied by .87. See explanations p. 178.

Nutrients and energy in daily food.—There are comparatively few statistics as to the amounts of nutrients and energy required by a child under two years of age, as compared with an older child or an adult. The following table gives the results of several dietary studies of very young children. Nos. 1 to 5 are German. No. 6 is the average of the two described above.* It will be noticed that there is no uniformity in the results. The child seven weeks old ate more than one of the children fourteen months of age.

* Published as dietary studies in the Report of this Station for 1895, p. 132.

TABLE 57.

Nutrients and energy in daily food consumed by children under 2 years of age.

Ref. No.	SUBJECT.	Protein.	Fat.	Carbo-hydrates.	Fuel Value.
		Grams.	Grams.	Grams.	Calories
1	Child, 7 weeks old, weight not given,	29	20	120	795
2	Child, 4 to 5 mos. old; weight, 5.5 kilos,	21	19	98	665
3	Child, 4 mos. old; weight, 6.6 kilos, -	8	26	63	535
4	Child, 14 mos. old; weight, 10.4 kilos, -	31	21	126	840
5	Child, 14 mos. old; weight, 6.0 kilos, -	23	22	106	735
6	Child, 8 to 9 mos. old; weight, 11.5 kilos,	50	59	62	1010*

* "As calculated" (by use of the factors 4.1 calories per gram of protein and carbohydrates, and 9.3 calories per gram of fats) for comparison with the others. By actual determination, 1090 calories.

1 and 2. Dietaries Nos. 1 and 2 are reported by Forster (Ztchr. f. Biol., 9, p. 405). The child in No. 1 was strong, healthy, and well nourished. Its parents were poor working people. No. 2 was rather sickly. Its parents were in comfortable circumstances.

3, 4, 5. Dietaries Nos. 3, 4, and 5 are reported by Camerer. No. 3, a girl, "brought up on mother's milk" (Ztchr. f. Biol., 33, 15, p. 521). No. 4, a girl (*Ibid*, 1892, p. 227). No. 5, a prematurely born child, brought up on artificial infants' foods (*Ibid*, 33, 15, p. 521).

6. The average of the digestion experiments here reported. The figures given represent food consumed, not food digested.

It has been assumed by various authorities that a child under two years of age will, on an average, require approximately from one-fourth to three-tenths as much food as an adult man. The average energy per day in the five dietaries of German children above (Nos. 1–5), is 715 calories, which is a trifle less than one-fourth of the energy of Voit's standard for a man at moderate muscular work (3050 calories). The fuel value of the food of the American child above is 1010 calories, practically three-tenths of that of the standard suggested by Atwater for a man at moderate muscular exercise (3500 calories). This value (.3) is the one used provisionally in the calculations of dietaries as explained on page 119.

It may be of interest to note here that a rough qualitative test showed but a comparatively small amount of calcium salts and of phosphoric acid in the feces while the ash of the milk and of the oatmeal contained these substances in relatively large amounts.

THE DIGESTIBILITY OF DIFFERENT CLASSES OF FOOD MATERIALS.

BY W. O. ATWATER.

In a discussion of the results of digestion experiments accompanying a compilation* prepared by the writer with the coöperation of Dr. C. Ford Langworthy, an attempt was made to summarize the results of the experiments made up to the time of the compilation (1895). The estimates for coefficients of digestibility, which were almost identical with those given on page 175 of the Report of this Station for 1892, were as follows: Animal foods: protein, 100† per cent.; fats, 95–98 per cent.; carbohydrates, 100 per cent. Vegetable foods: protein, 75–85† per cent.; fats, 95 per cent.; carbohydrates, 95 per cent.

Starting with these coefficients as a basis, food materials were divided into three general classes: 1. Animal foods, including meats, fish, eggs and dairy products. 2. Cereals and sugars, including the flours and meals from cereal grains, bakery products, starches and sugars. 3. Vegetables, including beans, peas and other leguminous seeds, and fruits. Coefficients of digestibility were assumed for the protein, fats and carbohydrates of each of the three classes. These coefficients were applied to the different classes of food materials used in some actual digestion experiment with a mixed diet. If the results obtained by the two methods, namely, by calculation and by experimental determination, agree closely, the agreement may be taken as indicating that the coefficients are approximately correct. While such a computation is not a complete mathematical demonstration, if the agreement is very close it may be regarded as sufficiently accurate for practical purposes.

* Bulletin No. 21 of the Office of Experiment Stations of the United States Department of Agriculture, On Methods and Results of Investigations on the Chemistry and Economy of Food, p. 70. The figures are practically the same as had been previously given by the writer as the outcome of a less extensive compilation, *Century Magazine*, September, 1887.

† These figures assume that the nitrogenous metabolic products of the feces belong to the digested protein.

The following figures were selected as giving very close agreement with values actually determined by experiment, and were then applied to a number of actual digestion experiments as shown in table 58 beyond. The nitrogenous metabolic products are here classed with undigested residue, thus lowering the coefficients for protein.

Assumed Coefficients of Digestibility.

	Protein.	Fat.	Carbo-hydrates.
Animal foods,	98 %	97 %	100 %
Cereals and sugars,	85 %	90 %	98 %
Vegetables and fruits,	80 %	90 %	95 %

To apply these figures we may take the food of a given experiment, as for instance, that of experiment No. 10, which consisted of meat, milk, butter, cheese, oatmeal and bread. In the tabular statement of details of this experiment above are shown the quantities of protein, fats and carbohydrates belonging to each food material. Assuming that 98 per cent. of the protein of the animal foods, meat, milk, butter, cheese and eggs, and that 85 per cent. of the protein of the oatmeal and bread was digested, we may calculate the amounts of protein digested from the total food eaten. Comparison of this with the total amount of protein will give the coefficient of digestibility of protein as calculated for this experiment. The computations are somewhat detailed and need not be given here. The result, however, will give a coefficient of 92.8 per cent. The coefficient as found by actual experiment was 94.4 per cent. The disparity between the two results amounts to 1.6 per cent. In the same way the coefficients for the other materials, fats and carbohydrates may be calculated and compared with those found by experiment. In table 58 such comparisons are made for experiments 6 and 10–14, above reported; that is to say, all of those in which there was a mixed diet with a considerable number of food materials. In the same table are given similar comparisons for experiments by Professor C. E. Wait, of the University of Tennessee. These experiments, which are not as yet published, belong to the series of inquiries which are being carried on at that institution in coöperation with the U. S. Department of Agriculture. It is through the courtesy of the Office of Experiment Stations that I am permitted to make use of the figures here quoted.

TABLE 58.

Coefficients of digestibility of nutrients in mixed diets. Comparisons of results of actual experiments with those obtained by calculating the digestibilities by use of the following coefficients:

	Protein.	*Fat.*	*Carbohydrates.*
Animal foods, - - - - -	98 %	97 %	100 %
Cereals, etc., - - - - -	85 %	90 %	98 %
Vegetables and fruits, - - -	80 %	90 %	95 %

Number.	SUBJECT.	DIET.	PROTEIN. Found by Expt.	PROTEIN. Cal-culated.	FAT. Found by Expt.	FAT. Cal-culated.	CARBO-HYDRATES. Found by Expt.	CARBO-HYDRATES. Cal-culated.
			%	%	%	%	%	%
6	Three chemists, -	Ordinary mixed diet, - -	91.1	91.3	96.2	96.5	99.2	97.2
10	Laboratory janitor, -	Meat, milk, butter, oatmeal, bread, sugar, - - -	94.4	92.8	96.6	96.7	98.5	98.2
11	Laboratory janitor, -	Meat, milk, butter, cheese, eggs, crackers, bread, sugar,	95.9	95.0	97.4	96.4	97.9	98.1
12	Laboratory janitor, -	Meat, milk, butter, cheese, eggs, crackers, bread, sugar,	91.8	93.7	97.1	96.3	98.4	98.0
13	Chemist, -	Mixed diet, - - - - -	94.9	93.8	96.9	96.6	98.9	97.1
14	Physicist, -	Mixed diet, - - - - -	91.3	91.5	95.9	96.3	97.7	97.7
		Avg. Nos. 6, 10, 11, 12, 13, 14,	**93.2**	**93.0**	**96.7**	**96.5**	**98.4**	**97.7**
20	Chemist, -	Bread and meat, - - -	93.2	94.9	92.0	96.0	97.4	97.8
21	Chemist, -	Bread and meat, - - -	95.4	96.0	96.3	96.3	96.9	98.0
22	Chemist, -	Bread, milk, eggs, - -	94.4	95.0	94.8	96.6	97.7	98.7
23	Chemist, -	Bread, milk, eggs, - -	95.2	95.5	93.8	96.7	96.8	98.8
24	Student, -	Bread, milk, eggs, - -	93.6	96.0	95.8	96.9	95.7	98.9
25	Chemist, -	Bread, milk, eggs, - -	96.0	94.4	94.1	93.5	97.8	98.4
		Average Nos. 20–25, - -	**94.6**	**95.3**	**94.5**	**96.0**	**97.1**	**98.4**
26	Chemist, -	Bread, milk, beef, oatmeal, sugar, bananas, - -	92.8	93.5	96.0	96.3	97.6	97.9
27	Chemist, -	Bread, milk, beef, oatmeal, sugar, bananas, - -	92.2	91.1	91.1	96.0	98.2	98.0
28	Chemist, -	Bread, milk, beef, oatmeal, sugar, bananas, - -	93.5	95.1	95.7	96.8	97.0	98.3
		Average Nos. 26–28, - -	**92.8**	**93.2**	**94.3**	**96.4**	**97.6**	**98.1**
		Average Nos. 20–28, - -	**94.0**	**94.6**	**94.4**	**96.1**	**97.2**	**98.3**
		Average all (15), - - -	**93.7**	**94.0**	**95.3**	**96.3**	**97.7**	**98.1**

RESULTS OF EXPERIMENTS ON THE PROPORTIONS OF NUTRIENTS DIGESTED FROM FOOD MATERIALS BY HEALTHY MEN.

The results of fifteen experiments are given above, with figures showing the proportions of nutrients digested from ordinary food materials by healthy men under conditions practically normal, except that the diet was less varied than usual. In each of these experiments the coefficients of digestibility of the nutrients were found by subtracting the ingredients of the feces from those of the food, and thus obtaining the proportion digested. It seems fair

to assume that these coefficients represent fairly well the digestibility of the food materials when used in mixed diet and under such circumstances as those of these experiments.

Coefficients of digestibility were taken from the results of other experiments and slightly modified and classified for the purpose of calculation. Applying these assumed coefficients to the food materials as used in an actual experiment, the proportions of digestible nutrients for that diet are readily calculated.

The results as found by the experiments described above and those calculated by use of the assumed coefficients just referred to agree with remarkable closeness. Differences in the individual experiments range from zero to a maximum of four per cent. (in a single case), and are generally less than two per cent. In the averages of the experiments they are much smaller. The amount of this variation is shown in the following summary:

TABLE 59.

Comparison of coefficients of digestibility as found by actual experiment with those calculated as described above.

Coefficients of Digestibility.		As Found by Experiment.	As Calculated.	Calculated coefficients (+) larger, or (−) smaller, than those found by experiment.
		%	%	%
Protein,	6 experiments here reported (Nos. 6, 10–14),	91.3	91.5	+ .2
	9 experiments by Prof. Wait (Nos. 20–28),	94.0	94.6	+ .6
	Average of 15 experiments,	**93.7**	**94.0**	**+ .3**
Fats,	6 experiments here reported (Nos. 6, 10–14),	96.7	96.5	— .2
	9 experiments by Prof. Wait (Nos. 20–28),	94.4	96.1	+ 1.7
	Average of 15 experiments,	**95.3**	**96.3**	**+ 1.0**
Carbohydrates,	6 experiments here reported (Nos. 6, 10–14),	98.4	97.7	— .7
	9 experiments by Prof. Wait (Nos. 20–28),	97.2	98.3	+ 1.1
	Average of 15 experiments,	**97.7**	**98.1**	**+ .4**

This close agreement implies that the assumed coefficients fairly represent the proportions of nutrients that are digested, under ordinary normal conditions, from such food materials as those used in these experiments. While they are not to be taken as an exact measure of the digestibility of every kind of food of a given class, nor, in every case as an exact measure of the average digestibility of the class as a whole, it seems probable that they do represent pretty fairly the average digestibility of these classes of food under ordinary circumstances.

THE AVERAGE COMPOSITION OF AMERICAN FOOD MATERIALS.

BY W. O. ATWATER.

The Report of this Station for 1891 contained an account of investigations upon the composition and nutritive value of food materials which had been conducted in the chemical laboratory of Wesleyan University, under the auspices of this Station and otherwise, up to that date. These included the analyses of a considerable number of specimens of American food materials. The results of these, and of similar analyses made elsewhere, were summarized in tables of the Composition of American Food Materials. Exclusive of dairy products, especially milk and butter; and sugar, molasses, sirups, etc., of which a large number of analyses had at that time been made for experimental and commercial purposes, and for inspection to prevent adulterations, the tables referred to contained results of some 400 to 500 analyses. The majority of these had been made in the writer's laboratory.

Since that time a large number of American analyses have accumulated, and a compilation of the results has been published in Bulletin 28 of the Office of Experiment Stations, U. S. Department of Agriculture.* A still later compilation has been prepared under the auspices of the Office of Experiment Stations, and now awaits publication in detail. This last includes such results as the compilers succeeded in finding up to July 1, 1896, but no attempt was made to obtain at all complete data for dairy products, sugars, etc., as above stated. The number of specimens of which analyses were included in this compilation was not far from 3,000, representing several hundred different kinds of food materials. Of these not far from 1,300 were made by the writer and his associates. Fully half of these 1,300, as well as some 900 by other chemists, have been made in connection with the food investigations now

* The Chemical Composition of American Food Materials. By W. O. Atwater and C. D. Woods.

being carried on in different parts of the country. Of the remaining 800, or thereabouts, by far the larger number were made by the Division of Chemistry of the U. S. Department of Agriculture. The extensive, varied, and important investigations upon the composition and adulterations of food materials which have been carried out by that Division, especially under the direction of Prof. H. W. Wiley, are too well known to require comment. In these statements no reference is made to the analyses of unground cereal grains, very extensive investigations of which have been made by the Division of Chemistry.

As the edition of the Bulletin of the Department of Agriculture above referred to is so limited as to make it accessible to comparatively few persons, and frequent requests come to the Station for information regarding the composition of food materials, the average composition of not far from 175 of some of the more common kinds is given in table 60. These figures are for the most part the same or nearly the same as those of the Bulletin 28 of the Office of Experiment Stations above referred to, the differences being only such as are called for by analyses which have accumulated since that Bulletin was compiled. Concerning the figures in this table, two remarks are called for:

1. The figures represent averages of analyses. Oftentimes different specimens of the same food will differ considerably in composition. This is particularly the case with meats and milk. Most kinds of vegetable foods are more nearly uniform in composition.

2. It is important to distinguish between those materials which contain more or less refuse and those which are entirely edible. In the table the designations "edible portion" and "as purchased" occur. The figures following the term "as purchased" represent the composition of the food material as ordinarily found in the markets. In the majority of foods, except dairy and cereal products, this includes more or less refuse as bone, shell, skin, or seeds. Where such inedible material, or refuse, occurs another average is given covering the composition of the "edible portion" after all refuse has been removed. Where the material as ordinarily purchased contains no refuse these terms are omitted.

TABLE 60.

Chemical composition of common food materials.

FOOD MATERIALS.		Refuse.	Water.	Protein.	Fat.	Carbo-hydrates.	Ash.	Fuel Value per Lb.
ANIMAL FOOD. *Beef (fresh).*		%	%	%	%	%	%	Cal.
Brisket,	Edible portion,	—	54.6	16.0	28.5	—	.9	1500
	As purchased,	23.3	41.6	12.2	22.3	—	.6	1170
Chuck, lean,	Edible portion,	—	71.2	19.9	7.8	—	1.1	700
	As purchased,	23.7	54.3	15.2	6.0	—	.8	535
Chuck, medium fat,	Edible portion,	—	67.4	19.0	12.6	—	1.0	885
	As purchased,	16.8	56.1	15.8	10.5	—	.8	735
Chuck, fat,	Edible portion,	—	62.3	18.0	18.8	—	.9	1125
	As purchased,	14.7	53.3	15.4	15.9	—	.7	955
Flank,	Edible portion,	—	60.2	17.9	21.0	—	.9	1220
	As purchased,	10.2	54.0	16.1	19.0	—	.7	1100
Loin, lean,	Edible portion,	—	67.0	19.3	12.7	—	1.0	895
	As purchased,	13.1	58.2	16.7	11.1	—	.9	780
Loin, medium fat,	Edible portion,	—	60.5	18.2	20.3	—	1.0	1195
	As purchased,	13.1	52.5	15.9	17.6	—	.9	1040
Loin, fat,	Edible portion,	—	54.7	16.8	27.6	—	.9	1475
	As purchased,	10.2	49.2	15.8	24.0	—	.8	1305
Neck,	Edible portion,	—	63.4	19.2	16.5	—	.9	1055
	As purchased,	27.6	45.9	13.9	11.9	—	.7	760
Plate,	Edible portion,	—	54.4	15.7	29.1	—	.8	1520
	As purchased,	16.5	45.3	13.1	24.4	—	.7	1275
Ribs, lean,	Edible portion,	—	67.9	19.1	12.0	—	1.0	860
	As purchased,	22.6	52.6	14.8	9.3	—	.7	670
Ribs, medium fat,	Edible portion,	—	55.5	17.0	26.6	—	.9	1440
	As purchased,	20.8	43.8	13.5	21.2	—	.7	1145
Ribs, fat,	Edible portion,	—	48.1	15.4	35.8	—	.7	1795
	As purchased,	16.1	39.5	12.6	31.2	—	.6	1550
Round, lean,	Edible portion,	—	70.3	20.9	7.7	—	1.1	715
	As purchased,	8.7	64.3	19.0	7.0	—	1.0	650
Round, medium fat,	Edible portion,	—	65.5	19.8	13.6	—	1.1	940
	As purchased,	7.2	60.7	18.3	12.8	—	1.0	880
Round, second cut,	Edible portion,	—	69.8	20.5	8.6	—	1.1	745
	As purchased,	19.5	56.2	16.5	6.9	—	.9	575
Rump,	Edible portion,	—	56.2	16.8	26.1	—	.9	1415
	As purchased,	21.6	44.1	13.1	20.5	—	.7	1110
Fore shank,	Edible portion,	—	67.9	19.6	11.6	—	.9	855
	As purchased,	36.9	42.9	12.3	7.3	—	.6	535
Hind shank,	Edible portion,	—	67.8	19.8	11.5	—	.9	855
	As purchased,	53.9	31.3	9.1	5.3	—	.4	395
Shoulder and clod,*	Edible portion,	—	68.3	19.3	11.3	—	1.1	835
	As purchased,	16.4	56.8	16.1	9.8	—	.9	715
Fore quarter, lean,	Edible portion,	—	68.6	18.4	12.2	—	.8	855
	As purchased,	22.3	53.3	14.3	9.5	—	.6	665
Fore quarter, med. fat,	Edible portion,	—	60.2	17.5	21.4	—	.9	1230
	As purchased,	19.3	48.6	14.1	17.3	—	.7	990
Fore quarter, fat,	Edible portion,	—	53.5	15.8	30.0	—	.7	1560
	As purchased,	21.7	41.9	12.4	23.4	—	.6	1220
Hind quarter, lean,	Edible portion,	—	66.9	19.2	12.9	—	1.0	900
	As purchased,	16.5	55.9	16.0	10.8	—	.8	755

* As usually cut the shoulder clod has no bone, *i. e.*, refuse.

TABLE 60.—*(Continued.)*

Chemical composition of common food materials.

FOOD MATERIALS.		Refuse.	Water.	Protein.	Fat.	Carbo-hydrates.	Ash.	Fuel Value per Lb.
ANIMAL FOOD. *Beef (fresh).*		%	%	%	%	%	%	Cal.
Hind quarter, med. fat,	Edible portion,	—	60.2	17.9	21.0	—	.9	1220
	As purchased,	16.4	50.4	14.9	17.5	—	.8	1015
Hind quarter, fat, -	Edible portion,	—	52.1	16.4	30.7	—	.8	1600
	As purchased,	14.1	50.0	14.8	20.4	—	.7	1135
Side, lean, - - -	Edible portion,	—	67.2	18.7	13.2	—	.9	905
	As purchased,	19.5	54.1	15.1	10.6	—	.7	730
Side, medium fat, -	Edible portion,	—	59.7	17.5	21.9	—	.9	1250
	As purchased,	18.2	49.0	14.4	17.7	—	.7	1015
Side, fat, - - -	Edible portion,	—	47.8	15.1	36.4	—	.7	1815
	As purchased,	13.2	41.5	13.1	31.6	—	.6	1575
Liver, - - - - - - -		—	71.1	20.9	5.0	1.6	1.4	630
Tallow (suet), - - - - - -		—	15.0	4.8	79.9	—	.3	3400
Beef (preserved).								
Tongue, canned, - - - - -		—	51.3	21.5	23.2	—	4.0	1380
Dried and smoked, - - - - -		—	50.8	31.8	6.8	.6	10.0	890
Tripe, pickled, - - - - - -		—	74.6	16.4	8.5	—	.5	665
Brisket, corned, - -	Edible portion,	—	50.9	18.7	24.7	—	5.7	1390
	As purchased,	21.4	40.0	14.7	19.4	—	4.5	1090
Flank, corned, - -	Edible portion,	—	49.9	14.2	33.0	—	2.9	1660
	As purchased,	12.1	43.7	12.4	29.2	—	2.6	1465
Plate, corned, - -	Edible portion,	—	40.1	13.3	41.9	—	4.7	2015
	As purchased,	14.5	34.3	11.4	35.8	—	4.0	1720
Rump, corned, - -	Edible portion,	—	58.1	15.3	23.3	—	3.3	1270
	As purchased,	6.0	54.5	14.4	22.0	—	3.1	1195
Canned, corned, - - - - - -		—	53.1	28.5	14.0	—	4.4	1120
Veal (fresh).								
Chuck, - - -	Edible portion,	—	73.3	19.2	6.5	—	1.0	630
	As purchased,	18.9	59.5	15.6	5.2	—	.8	510
Cutlets, - - -	Edible portion,	—	68.3	20.8	9.9	—	1.0	805
	As purchased,	4.0	65.6	20.0	9.5	—	.9	775
Leg, - - - -	Edible portion,	—	70.4	20.1	8.4	—	1.1	730
	As purchased,	15.6	59.4	16.9	7.2	—	.9	620
Loin, - - - -	Edible portion,	—	69.2	19.4	10.4	—	1.0	800
	As purchased,	17.3	57.2	16.0	8.6	—	.9	660
Shoulder, - - -	Edible portion,	—	70.5	20.1	8.2	—	1.2	720
	As purchased,	19.5	56.8	16.2	6.5	—	1.0	575
Fore quarter, - -	Edible portion,	—	71.7	19.4	8.0	—	.9	700
	As purchased,	24.5	54.2	14.6	6.0	—	.7	525
Hind quarter, - -	Edible portion,	—	70.9	19.8	8.3	—	1.0	720
	As purchased,	20.7	56.2	15.7	6.6	—	.8	570
Side, - - - -	Edible portion,	—	71.3	19.6	8.1	—	1.0	705
	As purchased,	22.6	55.2	15.1	6.3	—	.8	545
Lamb and Mutton (fresh).								
Chuck, lean, - -	Edible portion,	—	64.7	18.1	16.3	—	.9	1025
	As purchased,	19.5	52.1	14.5	13.1	—	.8	820
Chuck, medium fat, -	Edible portion,	—	50.9	14.6	33.6	—	.9	1690
	As purchased,	21.3	39.9	11.5	26.7	—	.6	1340
Chuck, fat, - -	Edible portion,	—	40.6	13.7	44.9	—	.8	2150
	As purchased,	16.5	33.8	11.5	37.5	—	.7	1795

TABLE 60.—*(Continued.)*

Chemical composition of common food materials.

Food Materials.		Refuse.	Water.	Protein.	Fat.	Carbohydrates.	Ash.	Fuel Value per Lb.
Animal Food.		%	%	%	%	%	%	Cal.
Lamb and Mutton (fresh).								
Leg, lean,	Edible portion,	—	67.4	19.1	12.4	—	1.1	880
	As purchased,	16.8	56.1	15.9	10.3	—	.9	730
Leg, medium fat,	Edible portion,	—	62.8	18.2	18.0	—	1.0	1100
	As purchased,	18.4	51.2	14.9	14.7	—	.8	900
Leg, fat,	Edible portion,	—	55.0	17.0	27.1	—	.9	1460
	As purchased.	12.4	48.2	14.8	23.8	—	.8	1280
Loin,	Edible portion,	—	50.2	15.9	33.1	—	.8	1695
	As purchased,	16.0	42.0	13.0	28.3	—	.7	1435
Shoulder,	Edible portion,	—	61.9	17.3	19.9	—	.9	1160
	As purchased,	22.5	47.9	13.4	15.5	—	.7	905
Fore quarter,	Edible portion,	—	52.9	15.3	30.9	—	.9	1590
	As purchased,	21.2	41.0	12.0	24.5	—	.7	1255
Hind quarter,	Edible portion,	—	54.8	16.3	28.1	—	.8	1490
	As purchased,	17.2	45.4	13.5	23.2	—	.7	1230
Side,	Edible portion,	—	53.6	15.8	29.8	—	.8	1580
	As purchased,	19.3	43.3	12.7	24.0	—	.7	1275
Pork.								
Chuck, shoulder,	Edible portion,	—	51.1	16.9	31.1	—	.9	1630
	As purchased,	18.1	41.8	13.8	25.5	—	.8	1335
Loin, lean,	Edible portion,	—	60.3	19.7	19.0	—	1.0	1165
	As purchased,	23.5	46.1	15.1	14.5	—	.8	895
Loin, medium fat,	Edible portion,	—	51.1	16.7	31.3	—	.9	1630
	As purchased,	16.3	42.8	14.0	26.2	—	.7	1365
Loin, fat,	Edible portion,	—	42.1	12.2	45.0	—	.7	2125
	As purchased,	14.6	35.7	10.4	38.7	—	.6	1825
Ham, fresh,	Edible portion,	—	44.0	13.4	41.8	—	.8	2015
	As purchased,	13.1	38.5	11.7	36.0	—	.7	1735
Ham, smoked, lean,	Edible portion,	—	53.5	20.2	20.8	—	5.5	1255
	As purchased,	11.5	47.2	17.9	18.5	—	4.9	1115
Ham, smoked, med. fat,	Edible portion,	—	40.7	15.5	39.1	—	4.7	1940
	As purchased,	14.4	34.9	13.3	33.4	—	4.0	1655
Ham, smoked, fat,	Edible portion,	—	27.9	16.1	52.3	—	3.7	2507
	As purchased,	3.4	25.2	14.2	53.8	—	3.4	2535
Ham, deviled, canned,	- - - -	—	45.3	18.9	32.9	—	2.9	1740
Shoulder, smoked,	Edible portion,	—	45.0	15.8	32.5	—	6.7	1665
	As purchased,	18.2	36.8	12.9	26.6	—	5.5	1360
Salt, fat,	- - - -	—	7.9	2.0	86.2	—	3.9	3675
Bacon,	Edible portion,	—	17.8	9.8	68.0	—	4.4	3050
	As purchased,	8.1	16.4	8.9	62.5	—	4.1	2800
Sausage,	- - - -	—	39.8	12.7	44.2	1.1	2.2	2130
Poultry.								
Chicken and fowl,	Edible portion,	—	64.5	19.2	15.3	—	1.0	1005
	As purchased,	26.6	47.2	14.0	11.5	—	.7	745
Turkey,	Edible portion,	—	55.5	20.6	22.9	—	1.0	1350
	As purchased,	22.7	42.4	15.7	18.4	—	.8	1070
Goose,	Edible portion,	—	42.3	13.0	43.9	—	.8	2095
	As purchased,	22.2	33.1	10.3	33.8	—	.6	1620

TABLE 60.—*(Continued.)*

Chemical composition of common food materials.

Food Materials.		Refuse.	Water.	Protein.	Fat.	Carbo-hydrates.	Ash.	Fuel Value per Lb.
ANIMAL FOOD. *Fish (fresh).*		%	%	%	%	%	%	Cal.
Blue fish,	Edible portion,	—	78.5	19.0	1.2	—	1.3	405
	As purchased,	48.6	40.3	9.8	.6	—	.7	205
Cod fish,	Edible portion,	—	82.6	15.8	.4	—	1.2	310
	As purchased,	29.9	58.5	10.6	.2	—	.8	205
Cod, steaks,	Edible portion,	—	79.7	18.6	.5	—	1.2	365
	As purchased,	9.2	72.4	16.9	.5	—	1.0	335
Flounder,	Edible portion,	—	84.2	13.9	.6	—	1.3	285
	As purchased,	57.0	35.8	6.3	.3	—	.6	130
Haddock,	Edible portion,	—	81.7	16.8	.3	—	1.2	325
	As purchased,	51.0	40.0	8.2	.2	—	.6	160
Halibut steak,	Edible portion,	—	75.4	18.3	5.2	—	1.1	560
	As purchased,	17.7	61.9	15.1	4.4	—	.9	465
Mackerel,	Edible portion,	—	73.4	18 2	7.1	—	1.3	640
	As purchased,	40.7	43.7	11.4	3.5	—	.7	360
Salmon,	Edible portion,	—	65.2	20.6	12.8	—	1.4	925
	As purchased,	29.5	48.1	13.5	8.1	—	.8	590
Brook trout,	Edible portion,	—	77.8	18.9	2.1	—	1.2	440
	As purchased,	48.1	40.4	9.8	1.1	—	.6	230
Shad,	Edible portion,	—	70.6	18.6	9.5	—	1.3	745
	As purchased,	43.9	39.6	10.3	5.4	—	.8	420
Fish (preserved).								
Salt cod,	Edible portion,	—	53.6	21.4	.4	—	24.6	415
	As purchased,	24.9	40.3	16.0	.4	—	18.4	315
Boned cod,	- - - -	—	54.4	22.2	.3	—	23.1	425
Smoked halibut,	Edible portion,	—	49.4	20.6	15.0	—	15.0	1015
	As purchased,	7.0	46.0	19.1	14.0	—	13.9	945
Smoked herring,	Edible portion,	—	34.6	36.4	15.8	—	13.2	1345
	As purchased,	44.4	19.2	20.2	8.8	—	7.4	745
Salt mackerel,	Edible portion,	—	42.2	22.0	22.6	—	13.2	1360
	As purchased,	22.9	32.5	17.0	17.4	—	10.2	1050
Canned salmon,	- - - -	—	64.1	20.8	11.7	1.0	2.4	900
Shell Fish.								
Long clams, in shells,	Edible portion,	—	85.8	8.6	1.0	2.0	2.6	240
	As purchased,	41.9	49.9	5.0	.6	1.1	1.5	140
Round clams, in shells,	Edible portion,	—	86.2	6.5	.4	4.2	2.7	215
	As purchased,	67.5	28.0	2.1	.1	1.4	.9	70
Oysters, solids,	- - - -	—	88.3	6.0	1.3	3.3	1.1	230
Lobster,	Edible portion,	—	79.2	16.4	1.8	.4	2.2	390
	As purchased,	61.7	30.7	5.9	.7	.2	.8	145
Canned lobster,	- - - -	—	77.8	18.1	1.1	.5	2.5	395
Eggs,	Edible portion,	—	73.0	15.0	11.0	—	1.0	745
	As purchased,	11.2	64.8	13.3	9.8	—	.9	660
Butter,	- - - -	—	—	—	*82.4	—	—	3475
Whole milk,	- - - -	—	87.0	3.3	4.0	5.0	.7	325
Skimmed milk,	- - - -	—	90.5	3.4	.3	5.1	.7	170
Butter milk,	- - - -	—	91.0	3.0	.5	4.8	.7	165

* Average percentage of butter-fat found in the Columbian Exposition butter test.

TABLE 60.—*(Continued.)*

Chemical composition of common food materials.

FOOD MATERIALS.	Refuse.	Water.	Protein.	Fat.	Carbo-hydrates.	Ash.	Fuel Value per Lb.
ANIMAL FOOD.	%	%	%	%	%	%	Cal.
Condensed milk,	—	30.5	8.2	7.1	52.3	1.9	1425
Cream,	—	74.0	2.5	18.5	4.5	.5	910
Cheese,	—	34.3	26.1	33.5	2.3	3.8	1940
Oleomargarine, butterine, etc.,	—	9.5	1.3	83.0	—	6.2	3525
Lard, cottolene, and tallow,	—	—	—	100.0	—	—	4220
VEGETABLE FOOD.							
Cereals, Sugar, Etc.							
Barley, pearled,	—	10.8	9.3	1.0	77.6	1.3	1660
Buckwheat flour,	—	14.2	5.8	1.0	78.2	.8	1605
Buckwheat, self-raising,	—	12.2	6.8	1.0	74.7	5.3	1560
Corn meal,	—	12.4	9.3	2.4	74.9	1.0	1665
Rolled oats,	—	7.2	16.6	7.2	66.9	2.1	1855
Rice,	—	12.2	7.8	.4	79.2	.4	1635
Rye flour,	—	12.9	6.8	.9	78.7	.7	1630
Graham flour,	—	11.4	13.7	2.2	70.9	1.8	1665
Entire wheat flour,	—	12.1	14.2	1.9	70.6	1.2	1660
Wheat flour,	—	12.0	11.4	1.1	75.1	.4	1655
Crushed wheat, wheatlet, farina, etc.,	—	10.4	11.4	1.7	75.7	.8	1690
Bread, white,	—	35.3	9.4	1.2	53.0	1.1	1210
Bread, rye,	—	33.5	9.9	.6	54.5	1.5	1220
Crackers, Boston,	—	8.2	10.7	9.9	68.8	2.4	1895
Crackers, milk,	—	6.1	10.5	12.5	69.1	1.8	2010
Crackers, oyster,	—	4.5	10.1	10.6	71.6	3.2	1965
Crackers, soda,	—	5.3	9.8	9.5	73.3	2.1	1945
Honey, strained,	—	18.0	.3	—	81.5	.2	1520
Molasses,	—	25.1	2.4	—	69.3	3.2	1335
Sugar, granulated,	—	—	—	—	100.0	—	1860
Sugar, brown,	—	—	—	—	95.0	—	1765
Maple sugar,	—	—	—	—	82.8	—	1540
Maple syrup,	—	—	—	—	70.1	—	1305
Starch,	—	6.0	—	—	93.8	.2	1745
Tapioca,	—	11.6	.4	.3	87.5	.2	1650
Vegetable.							
Beans, dry,	—	13.1	22.4	1.8	59.1	3.6	1590
Beans, green, shelled,	—	58.9	9.4	.6	29.1	2.0	740
Beans, string,	—	87.7	2.3	.3	8.9	.8	220
Beans, lima, green,	—	68.5	7.1	.7	22.0	1.7	570
Beets, Edible portion,	—	87.5	1.5	.1	9.8	1.1	215
Beets, As purchased,	20.0	70.0	1.2	.1	7.8	.9	170
Cabbage, Edible portion,	—	90.9	1.9	.3	5.7	1.2	155
Cabbage, As purchased,	15.0	77.3	1.6	.3	4.8	1.0	130
Carrots, Edible portion,	—	88.3	1.1	.3	9.2	1.1	205
Carrots, As purchased,	20.0	70.7	1.0	.2	7.2	.9	160
Cauliflower,	—	90.8	1.6	.8	6.0	.8	175
Celery,	—	93.7	1.3	.1	3.8	1.1	100
Sweet corn, green, Edible portion,	—	75.4	3.1	1.1	19.7	.7	470
Sweet corn, green, As purchased,	60.0	30.2	1.2	.4	7.9	.3	185

TABLE 60.—*(Continued.)*

Chemical composition of common food materials.

Food Materials.		Refuse.	Water.	Protein.	Fat.	Carbo-hydrates.	Ash.	Fuel Value per Lb.
Vegetable Food.		%	%	%	%	%	%	Cal.
Vegetable.								
Cucumbers,	Edible portion,	—	95.4	.8	.2	3.1	.5	80
	As purchased,	15.0	81.1	.7	.2	2.6	.4	70
Lettuce,	Edible portion,	—	94.0	1.3	.4	3.3	1.0	105
	As purchased,	18.0	77.1	1.1	.3	2.7	.8	85
Onions,	Edible portion,	—	87.1	1.7	.4	10.2	.6	240
	As purchased,	10.0	78.4	1.5	.4	9.2	.5	215
Parsnips,	Edible portion,	—	83.0	1.6	.5	13.5	1.4	300
	As purchased,	20.0	66.4	1.3	.4	10.8	1.1	240
Peas, dry,	- - - -	—	9.5	24.6	1.0	62.0	2.9	1655
Peas, green,	Edible portion,	—	74.1	6.6	.4	17.9	1.0	470
	As purchased,	50.0	37.1	3.3	.2	8.9	.5	235
Potatoes,	Edible portion,	—	78.0	2.2	.1	18.8	.9	395
	As purchased,	15.0	66.3	1.9	.1	16.0	.7	335
Pumpkins,	Edible portion,	—	93.1	1.0	.1	5.2	.6	120
	As purchased,	50.0	46.6	.5	—	2.6	.3	60
Radishes,	Edible portion,	—	91.8	1.3	.1	5.8	1.0	135
	As purchased,	30.0	64.2	.9	.1	4.1	.7	100
Rhubarb,	Edible portion,	—	94.4	.6	.7	3.6	.7	105
	As purchased,	40.0	56.6	.4	.4	2.2	.4	65
Squash,	Edible portion,	—	88.3	1.4	.5	9.0	.8	215
	As purchased,	50.0	44.2	.7	.2	4.5	.4	105
Sweet potatoes,	Edible portion,	—	69.0	1.8	.7	27.4	1.1	565
	As purchased,	15.0	58.7	1.5	.6	23.3	.9	485
Tomatoes,	- - - -	—	94.3	.9	.4	3.9	.5	109
Turnips,	Edible portion,	—	89.6	1.3	.2	8.1	.8	185
	As purchased,	30.0	62.7	.9	.1	5.7	.6	125
Vegetables (canned).								
Beans, baked,		—	68.4	6.9	3.1	19.6	2.0	625
Beans, string,		—	93.7	1.1	.1	3.7	1.4	95
Peas, green,		—	85.3	3.6	.2	9.8	1.1	255
Sweet corn,		—	75.7	2.8	1.3	19.3	.9	465
Squash,		—	87.6	.9	.5	10.5	.5	235
Succotash,		—	75.9	3.6	.9	18.7	.9	455
Tomatoes,		—	94.3	1.1	.2	3.8	.6	100
Fruit (fresh).								
Apples,	Edible portion,	—	83.5	.4	.5	15.2	.4	310
	As purchased,	25.0	62.6	.3	.4	11.4	.3	235
Bananas,	Edible portion,	—	75.2	1.2	.7	22.0	.9	460
	As purchased,	40.0	45.1	.7	.4	13.2	.6	275
Cherries,	Edible portion,	—	86.1	1.1	.8	11.4	.6	265
Cranberries,	- - - -	—	88.9	.4	.6	9.9	.2	215
Grapes,	Edible portion,	—	77.4	1.3	1.6	19.2	.5	450
	As purchased,	25.0	58.0	1.0	1.2	14.4	.4	335
Oranges,	Edible portion,	—	88.3	.8	.6	9.7	.6	220
	As purchased,	27.0	64.5	.6	.4	7.1	.4	160
Strawberries,	Edible portion,	—	90.4	1.0	.7	7.3	.6	185
	As purchased,	10.0	81.4	.9	.6	6.6	.5	165

TABLE 60.—*(Concluded.)*

Chemical composition of common food materials.

FOOD MATERIALS.		Refuse.	Water.	Protein.	Fat.	Carbo-hydrates.	Ash.	Fuel Value per Lb.
VEGETABLE FOOD.		%	%	%	%	%	%	Cal.
Fruit (preserved).								
Apples, dried, evaporated,		—	29.3	1.7	2.3	64.9	1.8	1335
Dates,	Edible portion,	—	15.4	2.1	2.8	78.4	1.3	1615
	As purchased,	9.8	13.8	1.9	2.5	70.8	1.2	1455
Prunes, dried,	Edible portion,	—	24.8	2.9	1.5	68.8	2.0	1395
	As purchased,	15.0	21.1	2.4	1.3	58.5	1.7	1190
Raisins,		—	14.6	2.6	3.3	76.1	3.4	1605
Apricots, dried,		—	32.4	2.9	*	63.3	1.4	1230
Peaches, canned,		—	91.5	.5	.2	7.5	.3	155
Nuts.								
Chestnuts, fresh,	Edible portion,	—	38.5	6.9	8.0	44.9	1.7	1300
	As purchased,	16.0	32.4	5.8	6.7	37.7	1.4	1090
Peanuts,	Edible portion,	—	9.2	25.8	38.6	24.4	2.0	2560
	As purchased,	33.0	6.2	17.3	25.9	16.3	1.3	1720
Beverages.								
Cocoa,		—	4.6	21.6	28.9	37.7	7.2	2320
Chocolate,		—	5.9	12.9	48.7	30.3	2.2	2860

* Fat not determined.

PROPORTIONS OF DIGESTIBLE NUTRIENTS IN FOOD MATERIALS.

BY W. O. ATWATER.

In all of the statements concerning the composition of food materials and estimates of the proportions of nutrients in dietaries and dietary standards published by the Station before the present Report, the total rather than the digestible nutrients have been considered. This usage has been followed in the publications of the Office of Experiment Stations, and by writers and teachers generally. The reason for not making the statements and calculations in terms of digestible nutrients has been a very simple one. The data regarding the digestibility of food materials as they are ordinarily eaten have been hardly sufficient to warrant going beyond the use of the total nutrients. The usage of chemists and physiologists in Europe has been practically the same as in this country, and for the same reason.

Tentative efforts have, nevertheless, been made toward the putting of the estimates of the nutritive values of foods and the standards for dietaries upon the basis of digestible nutrients. Thus Voit,* in 1882, using the results of Rübner's experiments on the digestion of food materials by men, has estimated the quantities of digestible nutrients corresponding to the total nutrients in his well-known standard for the daily dietary of an average man at moderate muscular work. His figures, as modified by König in 1889,† are:

	Protein.	*Fat.*	*Carbo-hydrates.*
Total, - - - - - - - -	118	56	500
Digestible, - - - - - - -	106	53	450

In like manner Von Rechendorff, in studies of dietaries of hand weavers in Zittau, Saxony, published in 1890,‡ has made detailed calculations of the proportions of both total and

* "Physiologie des Allgemeinen Stoffwechsels und der Ernährung."

† "Chemie der menschlichen Nahrungs und Genussmittel." Third edition, I., 154.

‡ Bulletin No. 21, Office of Experiment Stations, United States Department of Agriculture, On Methods and Results of Investigations with Chemistry and Economy of Food, p. 163.

digestible nutrients in a considerable number of dietaries. Similar attempts have been made by the writer from time to time.*

It has been the custom of both American and European chemists and physiologists, for a number of years, to make use of the figures for digestible nutrients in estimating the nutritive values of feeding stuffs and in calculating the rations for domestic animals. This has seemed to be warranted by the number of experiments in which the digestibility of feeding stuffs has been determined by actual tests.

The tests of the digestibility of food by man reported up to the present time are much less numerous than those of feeding stuffs by domestic animals, at the same time the variety of materials in common use, as food of man, is much larger than that of feeding stuffs for animals. It would thus seem, at first thought, that while the data may be sufficient for the setting up of coefficients of digestibility of feeding stuffs and basing calculations upon them, the information thus far accumulated is still too small to warrant us in applying the same principle to food materials.

There are, however, some considerations in favor of the use of the coefficients of digestibility for the food of man. In the first place our ordinary food materials are so much more easily and completely digestible than feeding stuffs that the undigested residue of food as used in ordinary diet under normal conditions by men, women, and children make a much smaller proportion of the whole than is the case with feeding stuffs as eaten by domestic animals. The variations in digestibility are likewise much less with the food of man. Indeed, this is specially the case with animal foods and with the carbohydrates which are the principal constituents in most vegetable foods. The variations in the digestibility of protein in the vegetable foods are somewhat wider. The determinations of the digestibility of fats of most vegetable foods, by the methods commonly followed, bring very uncertain coefficients of digestibility, because of the very small quantities of fats. The errors here, however, are of less practical consequence, because the fats of the vegetable foods make so small a proportion of the total diet.

One great difficulty with the larger number of digestion experiments hitherto made with man is found in the fact

* Bulletin 21, Office of Experiment Stations, p. 71. See also, *Century Magazine*, September, 1887.

referred to in the discussion of the subject of coefficients of digestibility in the preceding article, viz., that they have been made with single food materials, and the indications are that the digestion is less complete in these cases than it would be with ordinary mixed diet. In the article just referred to, the attempt was made to find coefficients of digestibility for the nutrients of different classes of food materials such as would, when applied to the constituents of ordinary mixed diet, give estimates for the quantities of digestible nutrients corresponding to the results of actual experiment with the same diet. From the data which had accumulated up to the present time coefficients of digestibility were assumed for the nutrients in different classes of foods, as explained on page 187. These coefficients were afterwards applied to a series of actual digestion experiments, and the proportion of estimated digestible nutrients obtained by their use was found to agree almost exactly with those obtained by actual experiment. The differences, indeed, were in most cases hardly wider than are often found in duplicate analyses of the same specimen of a given food material, by different chemists following the same analytical methods. Such coincidences were observed in a considerable number of cases. And it would appear that they could be hardly possible unless the assumed coefficients were tolerably close approximations to the truth. It seems safe, therefore, to use these coefficients for tentative estimates for the digestibility of some of the more common food materials. This is done in table 61. With reference to the computations, however, two things should be clearly understood:

First.—The estimates are only tentative and are subject to revision as information accumulates regarding both the composition and digestibility of the food materials. It is worth noting, however, that the probable errors in the figures assumed for the coefficients are apparently less than the known variations in the composition of different specimens of food materials of the same kind.

Second.—Some further distinctions need to be made between the coefficients of digestibility of different materials of the same general group. For instance, ordinary wheat flour, so-called "entire wheat flour" or "whole wheat," and graham flour

differ considerably in digestibility. But experimental data at hand are not sufficient to show what these differences are. Experiments upon this subject are now being carried on, however, under the auspices of the Office of Experiment Stations, and it is hoped that the needed information may be gradually acquired.

Fuel values.—In the following table the fuel values of the digested nutrients were calculated by the use of the factors proposed by Rübner and now ordinarily accepted as explained on page 177. The factor 4.1 as used for the fuel value of one gram of protein is evidently too small. Indeed, all the factors need revision to fit them to different food materials and conditions of use. It is hoped that results of investigations upon the subject now in progress in this laboratory may be published in the near future. Meanwhile the common factors are used in these calculations, but with the understanding that they will doubtless be changed later.

TABLE 61.

Estimates of proportions of digestible and undigestible nutrients in food materials. In these calculations it is assumed that the following percentages are digestible:

	Protein.	*Fat.*	*Carbohydrates.*	*Mineral Matters.*
Animal foods,	98 %	97 %	100 %	75 %
Cereals and sugars,	85 %	90 %	98 %	75 %
Vegetables and fruits,	80 %	90 %	95 %	75 %

FOOD MATERIALS.		Refuse.	Edible Portion. Water.	Nutrients. Digestible. Protein.	Fat.	Carbohydrates.	Mineral Matters.	Undigestible.	Fuel Value of Digestible Nutrients.
ANIMAL FOOD.		%	%	%	%	%	%	%	Cal.
Beef.									
Chuck,	Edible portion,	—	67.4	18.6	12.2	—	.7	1.1	860
	As purchased,	16.8	56.1	15.5	10.2	—	.6	.8	715
Loin,	Edible portion,	—	60.5	17.8	19.7	—	.8	1.2	1165
	As purchased,	13.1	52.5	15.6	17.1	—	.7	1.0	1010
Neck,	Edible portion,	—	63.4	18.8	16.0	—	.7	1.1	1025
	As purchased,	27.6	45.9	13.6	11.5	—	.5	.9	740
Ribs,	Edible portion,	—	55.5	16.7	25.8	—	.7	1.3	1400
	As purchased,	20.8	43.8	13.2	20.6	—	.5	1.1	1115
Round,	Edible portion,	—	65.5	19.4	13.2	—	.8	1.1	915
	As purchased,	7.2	60.7	17.9	12.4	—	.8	1.0	855

TABLE 61.—*(Continued.)*

Food Materials.		Refuse.	Edible Portion. Water.	Nutrients. Digestible. Protein.	Fat.	Carbo-hydrates.	Mineral Matters.	Undigestible.	Fuel Value of Digestible Nutrients.
ANIMAL FOOD.		%	%	%	%	%	%	%	Cal.
Beef.									
Rump,	Edible portion,	—	56.2	16.5	25.3	—	.7	1.3	1375
	As purchased,	21.6	44.1	12.8	19.9	—	.5	1.1	1080
Shank,	Edible portion,	—	67.8	19.4	11.2	—	.7	.9	835
	As purchased,	53.9	31.3	8.9	5.1	—	.3	.5	380
Shoulder,	Edible portion,	—	68.3	18.9	11.0	—	.8	1.0	815
	As purchased,	16.4	56.8	15.8	9.5	—	.7	.8	695
Fore quarter,	Edible portion,	—	60.2	17.2	20.8	—	.7	1.1	1200
	As purchased,	19.3	48.6	13.8	16.8	—	.5	1.0	965
Hind quarter,	Edible portion,	—	60.2	17.5	20.4	—	.7	1.2	1190
	As purchased,	16.4	50.4	14.6	17.0	—	.6	1.0	990
Liver,		—	71.1	20.5	4.9	1.6	1.1	.8	620
Corned, canned,		—	53.1	27.9	13.6	—	3.3	2.1	1090
Corned,	Edible portion,	—	54.5	15.3	24.7	—	3.3	2.2	1325
	As purchased,	9.4	49.6	13.9	22.1	—	3.0	2.0	1190
Dried, smoked,		—	50.8	31.8	6.8	.6	7.5	2.5	860
Veal.									
Chuck,	Edible portion,	—	73.3	18.8	6.3	—	.8	.8	615
	As purchased,	18.9	59.5	15.3	5.0	—	.6	.7	495
Cutlets,	Edible portion,	—	68.3	20.4	9.6	—	.8	.9	785
	As purchased,	4.0	65.6	19.6	9.2	—	.7	.9	755
Loin,	Edible portion,	—	69.2	19.0	10.1	—	.8	.9	780
	As purchased,	17.3	57.2	15.7	8.3	—	.7	.8	640
Shoulder,	Edible portion,	—	70.5	19.7	8.0	—	.8	1.0	705
	As purchased,	19.5	56.8	15.9	6.3	—	.8	.7	560
Side,	Edible portion,	—	71.3	19.2	7.9	—	.8	.8	690
	As purchased,	22.6	55.2	14.8	6.1	—	.6	.7	535
Mutton.									
Leg,	Edible portion,	—	62.8	17.8	17.5	—	.8	1.1	1070
	As purchased,	18.4	51.2	14.6	14.3	—	.6	.9	875
Loin,	Edible portion,	—	50.2	15.6	32.1	—	.6	1.5	1645
	As purchased,	16.0	42.0	12.7	27.5	—	.5	1.3	1395
Shoulder,	Edible portion,	—	61.9	17.0	19.3	—	.7	1.1	1130
	As purchased,	22.5	47.9	13.1	15.0	—	.5	1.0	880
Side,	Edible portion,	—	53.6	15.5	28.9	—	.6	1.4	1510
	As purchased,	19.3	43.3	12.4	23.3	—	.5	1.2	1215
Pork.									
Loin,	Edible portion,	—	51.1	16.4	30.4	—	.7	1.4	1590
	As purchased,	16.3	42.8	13.7	25.4	—	.5	1.3	1325
Ham, smoked,	Edible portion,	—	40.7	15.2	37.9	—	3.5	2.7	1885
	As purchased,	14.4	34.9	13.0	32.4	—	3.0	2.3	1605
Salt, fat,		—	7.9	2.0	83.6	—	2.9	3.6	3565
Bacon,	Edible portion,	—	17.8	9.6	66.0	—	3.3	3.3	2960
	As purchased,	8.1	16.4	8.7	60.6	—	3.1	3.1	2715

TABLE 61.—*(Concluded.)*

Food Materials.		Refuse.	Edible Portion.						Fuel Value of Digestible Nutrients.
				Nutrients.					
				Digestible.					
			Water.	Protein.	Fat.	Carbo-hydrates.	Mineral Matters.	Undigestible.	
Poultry.		%	%	%	%	%	%	%	Cal.
Chicken,	Edible portion,	—	64.5	18.8	14.8	—	.8	1.1	975
	As purchased,	26.6	47.2	13.7	11.2	—	.5	.8	730
Eggs,	Edible portion,	—	73.0	14.7	10.7	—	.8	.8	730
	As purchased,	11.2	64.8	13.0	9.5	—	.7	.8	645
Fish.									
Bluefish,	Edible portion,	—	78.5	18.6	1.2	—	1.0	.7	400
	As purchased,	48.6	40.3	9.6	.6	—	.5	.4	200
Codfish,	Edible portion,	—	82.6	15.5	.4	—	.9	.6	305
	As purchased,	29.9	58.5	10.4	.2	—	.6	.4	200
Cod, salt,	Edible portion,	—	53.6	21.0	.4	—	18.5	6.5	410
	As purchased,	24.9	40.3	15.7	.4	—	13.8	4.9	310
Salmon, canned,		—	64.1	20.4	11.3	1.0	1.8	1.4	875
Oysters, solids,		—	88.3	5.9	1.3	3.3	.8	.4	230
Butter,		—	—	—	80.0	—	—	2.4	3375
Milk, whole,		—	87.0	3.2	3.9	5.0	.5	.4	320
Milk, skim,		—	90.5	3.3	.3	5.1	.5	.3	170
Cheese,		—	34.3	25.6	32.5	2.3	2.9	2.4	1890
VEGETABLE FOOD.									
Buckwheat flour,		—	14.2	4.9	.9	76.6	.6	2.8	1555
Corn meal,		—	12.4	7.9	2.2	73.4	.8	3.3	1600
Oatmeal,		—	7.2	14.1	6.5	65.6	1.6	5.0	1755
Rye meal,		—	12.9	5.8	.8	77.1	.5	2.9	1575
Wheat flour,		—	12.0	9.7	1.0	73.6	.3	3.4	1590
Wheat bread,		—	35.3	8.0	1.1	51.9	.8	2.9	1160
Rye bread,		—	33.5	8.4	.5	53.4	1.1	3.1	1170
Crackers, milk,		—	6.1	8.9	11.3	67.7	1.4	4.6	1900
Sugar, granulated,		—	—	—	—	98.0	—	2.0	1825
Beans, dry,		—	13.1	17.9	1.6	56.1	2.7	8.6	1440
Beets,	Edible portion,	—	87.5	1.2	.1	9.3	.8	1.1	200
	As purchased,	20.0	70.0	1.0	.1	7.4	.7	.8	160
Cabbage,	Edible portion,	—	90.9	1.5	.3	5.4	.9	1.0	140
	As purchased,	15.0	77.3	1.3	.3	4.6	.8	.7	120
Onions,	Edible portion,	—	87.1	1.4	.4	9.7	.5	.9	225
	As purchased,	10.0	78.4	1.2	.4	8.7	.4	.9	200
Potatoes,	Edible portion,	—	78.0	1.8	.1	17.9	.7	1.5	370
	As purchased,	15.0	66.3	1.5	.1	15.2	.5	1.4	315
Sweet potatoes,	Edible portion,	—	69.0	1.4	.6	26.0	.8	2.2	530
	As purchased,	15.0	58.7	1.2	.5	22.1	.7	1.8	455
Apples,	Edible portion,	—	83.5	.3	.5	14.4	.3	1.0	295
	As purchased,	25.0	62.6	.2	.4	10.8	.2	.8	220
Bananas,	Edible portion,	—	75.2	1.0	.6	20.9	.7	1.6	430
	As purchased,	40.0	45.1	.6	.4	12.5	.5	.9	260
Strawberries,	Edible portion,	—	90.4	.8	.6	6.9	.5	.8	170
	As purchased,	10.0	81.4	.7	.5	6.3	.4	.7	150

FIELD EXPERIMENTS WITH FERTILIZERS.

BY C. S. PHELPS.

The field experiments conducted by the Station during the year 1896 have been carried out mainly on the Station land at Storrs. They have been almost wholly a continuation of experiments which were designed to run through a period of years, and of which accounts have been given in previous reports. The field work has been in four lines:—

1. Special nitrogen experiments on corn, legumes, and grasses; for the purpose of studying the effect of different quantities of nitrogen on the yield and composition of the crop.

2. A rotation soil test on the Station land for the purpose of studying the deficiencies of the soil and the needs of different crops for the different fertilizer ingredients.

3. Experiments on the improvement of light "plain land" soils by green manuring with legumes. These experiments will have to be continued at least another year before results of material value can be obtained.

4. The growing of different kinds of forage crops for use in soiling experiments with milch cows, and for digestion experiments with sheep. The main value of these experiments is in a study of the digestibility of soiling crops in different stages of growth. (See account of digestion experiments with sheep, beyond.)

SPECIAL NITROGEN EXPERIMENTS.

In the fall of 1894 the plots on the field at the Station that had been used for several years for special nitrogen experiments on grasses, were subdivided into a number of smaller plots of one-fiftieth of an acre each, and experiments were planned for the purpose of comparing the effects of fertilizers on the yield and composition of two varieties of corn, and several varieties of legumes. Each of the smaller plots was to have the same treatment as regards kinds and proportions of

fertilizers as the larger plots had received in the earlier experiments on grass. The plan of the experiment included a series of ten plots, two to be without fertilizers, and eight to have a fixed quantity, in each case, of "mixed minerals"—dissolved bone-black and muriate of potash. Of the eight fertilized plots, two were to have no nitrogen and six were to receive different kinds and amounts of nitrogen. On three of these last the nitrogen was applied in the form of nitrate of soda, supplying nitrogen at the rate of 25, 50 and 75 pounds per acre respectively, and the other three were supplied with sulphate of ammonia furnishing nitrogen at the same rates of 25, 50 and 75 pounds per acre.

Owing to the smallness of the plots it cannot be expected that the experiments will prove as valuable as regards the effect of fertilizers on yields as might be obtained on larger plots. It was thought, however, that the most important part of the experiment would be the effects of fertilizers on the composition of the plants, and that the results would be nearly as valuable from smaller plots as from larger, and a greater number of crops could thus be experimented upon.

EXPERIMENTS ON CORN.

This experiment was undertaken for the purpose of studying the effect of nitrogenous fertilizers on the yield and composition of two varieties of corn which differed quite widely in composition at the start; these two varieties to be grown for a period of years, with the same kinds and amounts of fertilizers. The seed was to be saved from the crop of each plot each year and planted again on the same plot the following year. This is the second year of the experiment. One variety of corn—the white flint—was chosen because it contained relatively large quantities of protein (13.0 per cent.) in the dry matter, while the other variety—a yellow flint—had been grown upon poor soil for many years, and contained relatively small quantities of protein (11.2 per cent.) in the dry matter. The two varieties were grown at opposite ends of the original large plots and were about 300 feet apart. The first season (1895) the seed of the two kinds mixed slightly, but care was taken to select the distinct kinds for seed in 1896. In that year the two kinds were planted about a week apart, and thus mixing was prevented.

The white flint corn was planted May 30, in check rows three feet apart each way, and the yellow flint was planted six days later. The fertilizer was applied to both series of plots broadcast on the 9th of June.

The growth on the plots without fertilizer was small. The plants were spindling, and of a pale color throughout the season. The mixed mineral plots (*6a* and *6b*) made nearly as heavy a growth of stalks as some of the plots receiving nitrogen, but the plants were pale colored throughout the season, and did not develop as heavy a growth of ears. The yields on the nitrogen plots were in most cases much smaller where only 25 pounds of nitrogen per acre were used than where larger amounts were added. The increased yields, however, where larger quantities of nitrogen were used did not seem to correspond to the increase in nitrogen. For example, the crop obtained where 50 pounds of nitrogen was used, was in most cases nearly or quite equal to that obtained where 75 pounds were added.

TABLE 62.

SPECIAL NITROGEN EXPERIMENT ON YELLOW FLINT CORN.

Weight and cost of fertilizers per acre, total crop, and increase of crop over that of the nothing plots.

Plot No.	Fertilizers.	Weight of Fertilizers.	Cost of Fertilizers.	Yield per Plot. (1-50 Acre.) Corn (ears).	Stover.	Percentage of Shelled Corn.	Yield per Acre of Shelled Corn. (11 % Water.)		Stover per Acre. (25 % Water.)	Gain over Nothing Plots.
		Lbs.	$	Lbs.	Lbs.	%	Lbs.	Bu.	Lbs.	Bu.
0	Nothing,	—	—	56	63	74.1	1671	29.8	2365	—
7	Mix'd Minerals, as No. 6a, Nit. of Soda (25 lbs. N.),	480 160	12.00	109	103	72.1	3114	55.6	3962	26.9
8	Mix'd Minerals, as No. 6a, Nit. of Soda (50 lbs. N.),	480 320	15.96	133	111	74.2	3933	70.2	3966	41.5
9	Mix'd Minerals, as No. 6a, Nit. of Soda (75 lbs. N.),	480 480	19.92	139	96	72.5	4066	72.6	3827	43.9
6a	Dis. Bone-black, } Mxd Mur. of Potash, } Min.	320 160	8.00	69	76	74.6	2113	37.7	2847	9.0
10	Mix'd Minerals, as No. 6a, Sulph. of Am. (25 lbs. N.),	480 120	12.44	125	124	75.6	3973	70.9	4762	42.2
11	Mix'd Minerals, as No. 6a, Sulph. of Am. (50 lbs. N.),	480 240	16.88	131	134	72.6	3793	67.7	4136	39.0
12	Mix'd Minerals, as No. 6a, Sulph. of Am. (75 lbs. N.),	480 360	21.32	140	116	73.9	4500	80.3	3959	52.6
00	Nothing,	—	—	53	66	70.6	1538	27.5	2367	—
6b	Mix'd Minerals, as No. 6a,	480	8.00	94	93	70.4	2724	48.6	3497	20.9

TABLE 63.

SPECIAL NITROGEN EXPERIMENT ON WHITE FLINT CORN.

Weight and cost of fertilizers per acre, total crop, and increase of crop over that of the nothing plots.

Plot No.	Fertilizers.	Weight of Fertilizers.	Cost of Fertilizers.	Yield per Plot. (1-50 Acre.) Corn (ears).	Yield per Plot. (1-50 Acre.) Stover.	Percentage of Shelled Corn.	Yield per Acre of Shelled Corn. (11 % Water.)		Stover per Acre (25 % Water.)	Gain over Nothing Plots.
		Lbs.	$	Lbs.	Lbs.	%	Lbs.	Bu.	Lbs.	Bu.
0	Nothing, - - - -	—	—	57	28	79.4	2137	32.8	1559	—
7	Mix'd Minerals, as No. 6*a*, Nit. of Soda (25 lbs. N.),	480 160	12.00	93	66	80.1	3318	59.3	3414	30.2
8	Mix'd Minerals, as No. 6*a*, Nit. of Soda (50 lbs. N.),	480 320	15.96	111	62	79.8	3932	70.2	3079	41.1
9	Mix'd Minerals, as No. 6*a*, Nit. of Soda (75 lbs. N.),	480 480	19.92	114	68	75.9	3829	68.4	3511	39.3
6*a*	Dis. Bone-black, Mxd Mur. of Potash, Min.	320 160	8.00	75	54	80.4	2867	51.2	2776	22.1
10	Mix'd Minerals, as No. 6*a*, Sulph. of Am. (25 lbs. N.),	480 120	12.44	78	70	78.2	2676	47.8	3296	18.7
11	Mix'd Minerals, as No. 6*a*, Sulph. of Am. (50 lbs. N.),	480 240	16.88	109	64	79.8	3858	68.8	2925	39.7
12	Mix'd Minerals, as No. 6*a*, Sulph. of Am. (75 lbs. N.),	480 360	21.32	118	78	78.5	4063	72.5	3605	43.4
00	Nothing, - - - -	—	—	43	25	78.0	1415	25.3	1378	—
6*b*	Mix'd Minerals, as No. 6*a*,	480	8.00	86	59	80.4	3012	53.8	2946	24.7

INFLUENCE OF NITROGEN ON THE PERCENTAGE OF PROTEIN.

The tables which follow give the percentages and yields of dry matter and the percentages and yields of protein per acre for the two varieties of corn. From these tables it will be seen that the crop on the "nothing" plots (those which had no fertilizer) often gave a higher percentage of protein than was obtained on many of the fertilized plots. Earlier work done by this Station shows that "poor" or immature corn generally has a higher percentage of protein than fully matured corn. This is believed to be due to the fact that in the immature condition of plants and seeds the percentage of nitrogen is naturally greater, while as the plants or seeds advance toward maturity the proportion of carbohydrates (starch, etc.,) is increased, and the proportion of protein is thus relatively lessened. In the case of the nothing plots the growth ceases before the corn reaches maturity. For

this reason it is much fairer in judging of the effects of nitrogen to compare the composition of the crop on the mineral plots (6*a* and 6*b*) with that on plots having nitrogen in addition to the mineral fertilizers. Thus, if we compare plots 7, 8, and 9 with 6*a* or 6*b*, we find that the percentages of protein* in both corn and stover are higher where nitrogen was used, and that the percentage of protein gradually increases with the quantity of nitrogen used. This is likewise true, with one exception, plot 11, in the corresponding plots 10, 11 and 12. This tends to show that the benefits obtained from the use of nitrogenous fertilizers on corn are two-fold. Up to a certain limit they tend to increase the yield of crop, and likewise increase the proportion of protein, and hence the feeding value of the crop.

Table 64.

SPECIAL NITROGEN EXPERIMENT ON CORN.

Percentages and pounds per acre of dry matter and of protein.

Plot No.	Fertilizers. (North Plots.)	Weight of Fertilizers.	Yellow Flint Corn. Grain.				Yellow Flint Corn. Stover.			
			Dry Matter.		Protein.*		Dry Matter.		Protein.	
		Lbs.	%	Lbs.	%	Lbs.	%	Lbs.	%	Lbs.
0	Nothing,	—	71.6	1486	9.90	147	56.3	1774	7.75	137
7	Mix'd Minerals, as No. 6*a*, Nit. of Soda (25 lbs. N.),	480 160	70.5	2769	9.34	259	57.7	2972	5.28	157
8	Mix'd Minerals, as No. 6*a*, Nit. of Soda (50 lbs. N.),	480 320	70.9	3496	10.76	376	53.6	2975	6.91	206
9	Mix'd Minerals, as No. 6*a*, Nit. of Soda (75 lbs. N.),	480 480	71.7	3615	11.68	422	59.8	2870	7.04	202
6*a*	Dis. Bone-black, } Mxd Mur. of Potash, } Min.	320 160	73.0	1879	9.31	175	56.2	2135	5.37	115
10	Mix'd Minerals, as No. 6*a*, Sulph. of Am. (25 lbs. N.),	480 120	74.7	3532	10.20	360	57.6	3572	5.45	195
11	Mix'd Minerals, as No. 6*a*, Sulph. of Am. (50 lbs. N.),	480 240	70.9	3372	9.87	333	46.3	3102	6.25	194
12	Mix'd Minerals, as No. 6*a*, Sulph. of Am. (75 lbs. N.),	480 360	77.3	4000	11.13	445	51.2	2964	8.54	253
00	Nothing,	—	73.1	1367	10.22	140	53.9	1775	6.70	119
6*b*	Mix'd Minerals, as No. 6*a*,	480	73.2	2422	9.38	227	56.4	2623	5.07	133

* The protein is estimated by multiplying the nitrogen by 6.25. The percentages of protein are those of the dry matter.

TABLE 65.

SPECIAL NITROGEN EXPERIMENT ON CORN.

Percentages and pounds per acre of dry matter and of protein.

Plot No.	FERTILIZERS. (*South Plots.*)	Weight of Fertilizers.	WHITE FLINT CORN. GRAIN. Dry Matter.		Protein. N. × 6.25.		WHITE FLINT CORN. STOVER. Dry Matter.		Protein. N. × 6.25.	
		Lbs.	%	Lbs.	%*	Lbs.	%	Lbs.	%	Lbs.
0	Nothing, - - - -	—	83.9	1899	11.14	212	83.5	1169	7.33	86
7	Mix'd Minerals, as No. 6*a*, Nit. of Soda (25 lbs. N.),	480 160	79.2	2950	10.17	300	77.6	2560	4.89	125
8	Mix'd Minerals, as No. 6*a*, Nit. of Soda (50 lbs. N.),	480 320	78.9	3495	11.40	398	74.5	2309	5.97	138
9	Mix'd Minerals, as No. 6*a*, Nit. of Soda (75 lbs. N.),	480 480	78.7	3404	12.46	424	77.4	2633	8.30	219
6*a*	Dis. Bone-black, } Mxd Mur. of Potash, } Min.	320 160	84.5	2548	9.58	244	77.1	2082	4.77	99
10	Mix'd Minerals, as No. 6*a*, Sulph. of Am. (25 lbs. N.),	480 120	78.0	2378	10.91	259	70.6	2472	4.70	116
11	Mix'd Minerals, as No. 6*a*, Sulph. of Am. (50 lbs. N.),	480 240	78.8	3429	10.96	376	68.5	2194	5.81	127
12	Mix'd Minerals, as No. 6*a*, Sulph. of Am. (75 lbs. N.),	480 360	78.0	3611	12.04	435	69.3	2704	6.99	189
00	Nothing, - - - -	—	75.0	1258	11.21	141	82.6	1034	6.37	66
6*b*	Mix'd Minerals, as No. 6*a*,	480	77.5	2678	9.82	263	74.9	2210	4.52	100

* Percentages of protein in dry matter.

EXPERIMENTS ON COW PEAS.

On two series of plots of one-fiftieth of an acre each, similar to those on which the corn was grown, cow peas were planted. The results obtained on the two sets of plots were added together and are reported as one experiment. The kinds and amounts of fertilizers per plot were exactly the same as on the corn plots. The seed was planted in drills, June 5th, at the rate of about one bushel per acre. In this experiment it is impossible to use the seed of the crop of the year before, as the cow peas do not mature seed in this climate. The seed has been obtained each year from Tennessee. It will be noticed from the table which follows that there was a large increase in yield on the mixed mineral plots (6*a* and 6*b*) over that obtained on the nothing plots, and that in the case of the nitrate of soda plots, 7, 8 and 9, there was quite an increase over that obtained from mineral fertilizers alone. The increase derived from the use of nitrogen was not very marked, however, as it will be

seen that the largest yield, 10.4 tons per acre, was obtained where only 25 pounds of nitrogen were added. Both in 1895 and 1896 the larger quantities of sulphate of ammonia seemed to depress the yields. The hypothesis has been suggested that the repeated use of sulphate of ammonia through quite a period of years may have induced an acid condition of the soil. This might be unfavorable to the growth and development of bacteria and to the formation of tubercles. It has been noticed that the proportion of tubercles on the roots of the plants on these plots was much less than on corresponding plots where nitrate of soda was employed. As to the correctness of the hypothesis and the advantage of using slaked lime to correct the acidity, we have no experimental data to warrant any conclusions.

TABLE 66.

SPECIAL NITROGEN EXPERIMENT ON COW PEA FODDER.

Weight and cost of fertilizers per acre, total crop, and increase of crop over that of the nothing plots.

Plot No.	Fertilizers.	Weight of Fertilizers.	Cost of Fertilizers.	Cow Pea Fodder. Yield per Plot. (1-25 Acre.)	Cow Pea Fodder. Yield per Acre. (80 % Water.)		Gain over Nothing Plots.
		Lbs.	$	Lbs.	Lbs.	Tons.	Lbs.
0	Nothing,	—	—	450	10295	5.1	—
7	Mixed Minerals, as No. 6a, Nitrate of Soda (25 lbs. N.),	480 160	12.00	938	20750	10.4	10198
8	Mixed Minerals, as No. 6a, Nitrate of Soda (50 lbs. N.),	480 320	15.96	925	19770	9.9	9217
9	Mixed Minerals, as No. 6a, Nitrate of Soda (75 lbs. N.),	480 480	19.92	985	20440	10.2	9761
6a	Dis. Bone-black, } Mixed Mur. of Potash, } Minerals,	320 160	8.00	923	17420	8.7	6856
10	Mixed Minerals, as No. 6a, Sulph. of Am. (25 lbs. N.),	480 120	12.44	866	17860	8.9	8064
11	Mixed Minerals, as No. 6a, Sulph. of Am. (50 lbs. N.),	480 240	16.88	826	17760	8.9	4623
12	Mixed Minerals, as No. 6a, Sulph. of Am. (75 lbs. N.),	480 360	21.32	818	15030	7.5	6420
00	Nothing,	—	—	414	10815	5.4	—
6b	Mixed Minerals, as No. 6a,	480	8.00	828	17655	8.8	7104

TABLE 67.

SPECIAL NITROGEN EXPERIMENT ON COW PEAS.

Percentages and pounds per acre of dry matter and of protein.

Plot No.	Fertilizers.	Wt. of Fertilizer.	Dry Matter.		Protein. N.X 6.25.	
		Lbs.	%	Lbs.	% *	Lbs.
0	Nothing,	—	18.3	2059	16.8	346
7	Mixed Minerals, as No. 6*a*, Nitrate of Soda (25 lbs. N.),	480 160	17.7	4150	16.8	697
8	Mixed Minerals, as No. 6*a*, Nitrate of Soda (50 lbs. N.),	480 320	17.1	3954	18.9	747
9	Mixed Minerals, as No. 6*a*, Nitrate of Soda (75 lbs. N.),	480 480	16.6	4088	19.5	797
6*a*	Dissolved Bone-black, } Mixed Muriate of Potash, } Minerals,	320 160	15.1	3488	19.7	687
10	Mixed Minerals, as No. 6*a*, Sulphate of Ammonia (25 lbs. N.),	480 120	16.5	3572	19.0	679
11	Mixed Minerals, as No. 6*a*, Sulphate of Ammonia (50 lbs. N.),	480 240	17.2	3552	16.6	590
12	Mixed Minerals, as No. 6*a*, Sulphate of Ammonia (75 lbs. N.),	480 360	14.7	3006	21.4	643
00	Nothing,	—	20.9	2163	20.0	433
6*b*	Mixed Minerals, as No. 6*a*,	480	17.4	3531	18.2	643

* Percentages of protein in dry matter.

YIELDS OF PROTEIN PER ACRE.

It is of interest to note the percentages and total yields of protein per acre in the cow peas as compared with the corn where the same kinds and amounts of fertilizers were used. In the case of the cow peas there seems to be very little relationship between the percentages of protein in the crop and the quantity of nitrogen used in the fertilizer. The average yield of protein on the plots having only mineral fertilizers was 19 per cent., while the average yield on the three plots having nitrate of soda was 18.4 per cent., and on the three plots having sulphate of ammonia, 19 per cent. The yields of dry matter per acre were not much more than half as much from the cow peas as was obtained from the corn and stover on similar plots, yet the total yield of protein per acre was greater in all cases with the cow peas than on the corresponding plots with corn.

This emphasizes the high feeding value of the cow peas. This crop has been used for several years on the College farm,

both for feeding green and for mixing with corn for producing a mixed silage with a higher percentage of protein than would be obtained from corn silage alone.

SOIL TEST EXPERIMENT BY THE STATION.

This experiment is the seventh in a series planned as a rotation soil test experiment, the same kinds of fertilizers being used on the same plots year after year. Beginning with 1890, the crops grown on this field have been corn, potatoes, oats, cow peas, corn, potatoes, and oats.

ARRANGEMENT OF PLOTS IN STATION EXPERIMENT.

UNMANURED STRIPS SEPARATE THE PLOTS.

EAST.

NORTH.			SOUTH.
	Plot o.	Plot Y.	
	Plot A.	Plot X.	
	Plot B.	Plot ooo.	
	Plot C.	Plot G.	
	Plot oo.	Plot F.	
	Plot D.	Plot E.	
	Plot E.	Plot D.	
	Plot F.	Plot oo.	
	Plot G.	Plot C.	
	Plot ooo.	Plot B.	
	Plot X.	Plot A.	
	Plot Y.	Plot o.	

WEST.

The field slopes gently to the south, but not enough to cause serious washing. The soil is a heavy loam, and the subsoil is a yellow, clay loam. In 1889 it was noticed that the soil seemed to be poorer toward the west side of the field. For this reason the field was laid out into two half-acre experiments, the order of the plots on the two being reversed, as per diagram.

The yields of the duplicate plots in each case are added in estimating the yield per acre. This helps to eliminate the errors due to irregularities of soil. Beside the regular soil test, two other plots were added—one (X) with a medium

amount (10,000 pounds per acre) of manure, and in addition dissolved bone-black at the rate of 160 pounds per acre; the other (Y) with a larger quantity (16,000 pounds) of stable manure, but without bone-black.

The field was seeded to oats on the 29th of April, at the rate of two and one-third bushels per acre. The paths between the plots were seeded in the same manner as the plots. The fertilizer was applied to the plots at the rates shown in the following table, on the 30th. This is the seventh crop grown on this field since the experiment was begun, the kinds and amounts of fertilizers being the same each year. Quite a marked difference in the growth on the different plots could be observed throughout the season. On July 7th, plots having phosphoric acid applied in the fertilizer showed an increase in growth over other plots. Plots without nitrogen were pale colored, although the growth was nearly as large as on the plots with nitrogen. From the table which follows it will be seen that where only one ingredient of plant food was used (plots A, B, and C,) the nitrogen had the greatest influence on the yield, while on plots where two ingredients were combined (D, E, and F,) nitrogen and phosphoric acid (plot D) gave the best results. Plot G, with all three of the fertilizing ingredients, gave very little increase over D, to which no potash was applied. This tends to show that on the soil experimented upon potash did not prove of much value for the oat crop, while nitrogen and phosphoric acid increased the yields to a marked extent. In this respect the experiment agrees with the oat experiment of four years ago (1892) on the same plots. Experiments conducted on this field with potatoes show that potash and nitrogen had a very marked influence on the yield, while phosphoric acid gave comparatively little increase. This seems to indicate that the special needs of different crops, as well as the deficiencies of the soil, must be taken into consideration before fertilizers can be used with the best results. It will be of interest to compare the yields obtained with different crops during the past seven years, as shown in the table below the one giving the yields of oats for 1896.

TABLE 68.

SOIL TEST WITH FERTILIZERS ON OATS.

BY THE STATION, STORRS.

Plot No.	Fertilizers per Acre. Kind.	Weight.	Cost.	Yield per Plot. (1-12 Acre.) Oats.	Yield per Plot. (1-12 Acre.) Straw.	Yield per Acre. Oats.*	Yield per Acre. Straw.	Yield per Acre. Gain over Nothing Plots.	Yield per Acre. Wgt. per Bushel.
		Lbs.	$	Lbs.	Lbs.	Bu.	Lbs.	Bu.	Lbs.
O	Nothing,	—	—	79	89	29.6	1068	0.0	30.9
A	Nitrate of Soda,	160	3.96	104	140	39.0	1680	10.6	29.3
B	Dis. Bone-black,	320	4.40	93	116	34.9	1392	6.5	32.5
C	Muriate of Potash,	160	3.48	74	99	27.8	1188	—.6	30.6
OO	Nothing,	—	—	70	89	26.3	1068	0.0	29.0
D	Nitrate of Soda, Dis. Bone-black,	160 320	8.48	128	169	48.0	2028	19.6	33.0
E	Nitrate of Soda, Muriate of Potash,	160 160	7.52	110	156	41.3	1872	12.9	31.0
F	Dis. Bone-black, Muriate of Potash,	320 160	8.00	97	125	36.4	1500	8.0	33.6
G	Nitrate of Soda, Dis. Bone-black, Muriate of Potash,	160 320 160	12.00	135	194	50.6	2328	22.2	34.0
OOO	Nothing,	—	—	78	92	29.3	1104	0.0	28.7
X	Stable Manure, Dis. Bone-black,	10000 160	18.80	130	184	48.8	2208	20.4	33.2
Y	Stable Manure,	16000	19.20	147	195	55.1	2340	26.7	33.1

* Thirty-two pounds per bushel.

The yields obtained on this field during the past seven years are shown in the following table:

TABLE 69.

Yields on Station soil test experiment for past seven years.

Plot No.	Fertilizers.	Weight per Acre.	Corn. 1890.	Potatoes. 1891.	Oats. 1892.	Cow Peas (vines). 1893.	Corn. 1894.	Potatoes. 1895.	Oats. 1896.
		Lbs.	Bu.	Bu.	Bu.	Lbs.	Bu.	Bu.	Bu.
O	Nothing,	—	28.9	89	29.1	10230	33.6	55	29.6
A	Nitrate of Soda,	160	32.4	105	36.0	10960	41.0	50	39.0
B	Dis. Bone-black,	320	33.3	97	27.0	10710	37.6	56	34.9
C	Muriate of Potash,	160	30.4	171	26.3	11680	40.8	88	27.8
OO	Nothing,	—	26.7	87	24.2	9725	28.0	38	26.3
D	Nitrate of Soda, Dis. Bone-black,	160 320	36.1	110	37.9	12920	40.8	57	48.0
E	Nitrate of Soda, Muriate of Potash,	160 160	32.8	160	30.0	13335	47.6	104	41.3
F	Dis. Bone-black, Muriate of Potash,	320 160	34.4	214	27.8	15790	48.2	109	36.4
G	Nitrate of Soda, Dis. Bone-black, Muriate of Potash,	160 320 160	37.4	259	39.4	16210	58.2	129	50.6
OOO	Nothing,	—	28.5	88	22.5	12100	38.0	49	29.3
X	Stable Manure, Dis. Bone-black,	10000 160	44.1	210	40.9	15795	57.0	110	48.8
Y	Stable Manure,	16000	43.6	250	41.3	15875	56.7	125	55.1

IRRIGATION IN CONNECTICUT.*

BY C. S. PHELPS.

The subject of irrigation as related to the arid regions has received special attention during the past twenty years. Millions of dollars have been expended by individuals and corporations in some half dozen of the Pacific Coast and Rocky Mountain States, in order that fruits and grains may be made to flourish on what would otherwise be barren soils, and within the past few years Congress has made liberal appropriations for investigating the best methods of agriculture by irrigation. Up to the present time, however, little has been done in the Eastern States in the use of irrigation either on farm, garden, or orchard crops. But its great value has been demonstrated in a few striking instances by some of our leading fruit growers, and these instances, together with the general interest that is being manifested in the subject, show the need of inquiry. Within the past two years there has been a lively agitation of the subject through the agricultural press of the East, and farmers and small fruit growers are beginning to appreciate the value of artificial watering, and an increasing demand seems to exist for all the information obtainable on the subject.

In the Eastern portions of this country the intensive system of agriculture is rapidly replacing the extensive. This has become necessary because of the rapidly increasing population and a corresponding increase in the value of lands. In the past fifty years the agriculture of New England has been entirely changed. A system of mixed husbandry has been largely replaced by special branches of farming. The many thriving manufacturing cities and towns that are being built up have caused a great demand for fruits and vegetables.

* The substance of this article is about to appear as part of a longer article by the author in a Bulletin of the Office of Experiment Stations of the United States Department of Agriculture.

These products have proven especially profitable where markets are near at hand. The high value per acre and the active and increasing demand for fresh fruits and vegetables, have induced many of our farmers to enter upon the production of these crops, and it is in such lines of farming as fruit growing and market gardening that irrigation has its highest value. In regions where the value of farm lands is high the farmer must obtain large crops, and those of the best quality, in order to pay taxes and obtain a fair profit on his investment, and to do this he must not only cultivate highly, but adopt every means within his power to prevent losses. Where the cost of cultivation is large the losses from drouth are felt all the more severely, as the expenses are essentially the same whether a half crop or a full crop is harvested. In the Eastern part of this country drouths are not usually of long duration, but short severe drouths are common, and they cause heavy losses to market gardeners and fruit growers. Losses of from one to two hundred dollars per acre as a result of a few weeks' drouth are not uncommon. The area devoted to strawberry culture the past season in Connecticut is estimated at not less than 500 acres. With this total acreage a loss of $100 per acre means $50,000 on a single crop, for one small State.

The experience of practical men and the experiments cited beyond indicate that an investment in an irrigation plant where market garden crops and small fruits are grown will pay exceptionally good interest. This is because of the high value per acre of such crops and the fact that in many instances the cost of getting and applying the water is small. The cost of applying water for strawberries, when an irrigation plant is once established, need not exceed $10 per acre, while the increased yields resulting from its use may often amount to $100 to $200 per acre.

IMPORTANCE OF WATER IN PLANT GROWTH.

The most important factors influencing the growth of plants are water, food, heat and light. The influence of the last three of these has been quite extensively studied, but with regard to the relation of water, one of the most important of all of these factors, but little is known. The importance of an adequate supply of water in the growth of plants is well

illustrated in greenhouse culture, where nearly all of the soil receives a thorough wetting once in two or three days. Here, also, heat and light are to a great extent under control. In field culture heat and light cannot be controlled, but food and water may. The subject of fertilizers and manures and their influence on the growth of farm crops has been carefully investigated during the past twenty-five years. Fertilizers, however, are of little use without an abundance of water to render them available for the plant. One of the most serious drawbacks in conducting field experiments with fertilizers is the fact that the water supply cannot readily be regulated. It frequently happens that in seasons of drouth the value of such field experiments is almost destroyed; or if deductions are drawn from them without regard to the moisture conditions of the particular season, such deductions are apt to be very misleading.

It is important to study all possible means for conserving the water in the soil by preventing its escape, and thus retaining it where it will be available for the plant when most needed. Much can be done to this end by the addition of humus, either in the form of stable manure, or other decaying vegetable or animal matter, or by placing some suitable mulch on the surface of the ground, or by forming a mulch from the surface layers of the soil by frequent cultivation; but with all these helps crops will at times suffer for want of the necessary water to keep up a vigorous growth, unless an artificial supply is provided.

A large proportion of the weight of most plants is water. This is familiar to all, in the fact so readily observed, that plants and fruits lose weight rapidly in drying. In every 100 pounds of freshly cut grass there are from seventy to eighty pounds of water; while clovers frequently contain over eighty per cent. Nearly all of our common fruits, such as strawberries, raspberries, pears, and peaches, contain from eighty to ninety-two per cent. of water. The importance of this to the farmer is seen in the fact that when he sells such crops off the farm he is mainly disposing of water and a small amount of mineral salts.

The water held in the substance of the plant, however, represents only a small part of that needed in its growth; a large amount is transpired through the foliage during the period of the plant's development.

It has been estimated that a crop of hay at two tons per acre, or about six and one-half tons of fresh grass, will evaporate during its season of growth about 525 tons of water; that an average crop of wheat, of 720 pounds of grain and 1500 pounds of straw to the acre, will evaporate about 260 tons of water, or, in other words, according to these estimates, every ton of green grass evaporates through its foliage during the period of growth about eighty-one tons of water, and in drying, this ton of grass loses about two-thirds of its weight, so that one-third of a ton of hay (667 pounds), utilizes in its growth about eighty-one tons of water. An inch of rainfall is equal to 113 tons of water per acre. The above figures indicate that the water evaporated by the hay crop would equal about four and six-tenths inches of water and the wheat crop two and three-tenths inches. These figures, of course, only represent averages. In very moist times evaporation would be checked and in dry times it would be increased. In other words, at the times when the plant uses water most rapidly there is the least available amount from the rainfall.

The importance of water in the growth of crops may again be illustrated in a remarkable way by the experiments in water culture which have been carried on for many years, especially in the German Experiment Stations. In these experiments plants are grown, not in soil at all, but with their roots immersed in water. The seeds are allowed to sprout in some convenient medium, as sand or moist cotton, or in an apparatus devised for the purpose. When the roots are started the plantlets are suspended at the tops of jars so that the roots dip into water with which the jars are nearly filled. The water in the jars holds in solution the materials which the plantlets ordinarily obtain from the soil. The roots find this material in the water, use it, and the plants grow. Solutions containing all the essential soil ingredients of plant food are called normal solutions. In these plants are raised as large and healthy and in every way as perfect as those grown in even the richest soil.

The same principle as that illustrated in water culture is involved in all growth of plants by irrigation. In the irrigated regions of Lombardy, in Italy, eight or nine or more crops of grass are frequently cut in a single season. On the same land

and with the same manuring, but without the irrigation, only ordinary crops could be obtained.

A large and variable quantity of water is evaporated directly from the soil. The amount of this depends upon several conditions, the chief of which are the state of the weather, the kind of crop on the soil, the amount of cultivation, and whether or not the soil is mulched. In times when rainfall is insufficient for the best growth of crops the atmospheric conditions are usually such as to favor the evaporation of moisture from the soil. The amount of evaporation that takes place depends upon the amount of wind that may be blowing over the soil, and the degree of saturation of the air. Meteorologic data showing the relative humidity of the air frequently indicate that on hot, dry days the air contains as low as from twenty to fifty per cent. of its water-holding capacity. Under such conditions, especially in connection with winds, the moisture evaporates from the soil very rapidly. The shade afforded by crops like grass and small grains tends to lessen the amount of evaporation from the soil, while crops which do not shade the ground as much furnish conditions more favorable for the escape of moisture. It is a well-known fact that mulch in the form of coarse hay, straw, etc., tends to prevent the escape of moisture. This, together with the cleaner fruit that results, is one of the reasons for using such materials on strawberry fields. Frequent stirring of the surface soil by cultivation has much the same effect in preventing the escape of moisture as the direct use of mulch. In the experiments by the writer, on the evaporation of moisture from heavy loam and light loam soils, the soils in a part of each series were frequently stirred at the surface, while the others were not stirred. The average loss of moisture from the soil not stirred was equal to one and one-third inches, while the average loss from the stirred soil was three-quarters of an inch. This means that not far from twice as much water was evaporated from the soil left in a naturally compact condition over that lost where the surface was mulched by frequent stirring.

It is frequently the case that plants require a very large amount of water during a short period of time at certain seasons of the year. This is especially true when they are developing fruit. An abundant supply of water just before

and at the ripening season of strawberries usually means a good crop, while a ten days' drouth at this time will often reduce the crop one-third to one-half below a normal yield. Nearly every farmer knows that plenty of rainfall when potatoes are "setting" is favorable to a large crop, while drouth at this time is almost sure to seriously diminish the yield. Short periods of drouth will often so check plant growth that even if these periods be followed by copious rainfalls the crop does not fully recover itself. This is especially true with grass. A short hay crop is almost certain to result if the rainfall is small during the month of May.'

NEED OF IRRIGATION IN CONNECTICUT.

The majority of people fail to realize that irrigation has any place in New England agriculture. It is generally thought that our annual rainfall is sufficient to meet the needs of most, if not all, of our farm crops, and that any considerable expenditure of money for irrigation would not repay the expense, unless in very exceptional cases. The rainfall, however, is very unevenly distributed throughout the year. Short, severe drouths are a characteristic of this climate. A high temperature, accompanied by drying winds, will, in a week's time, frequently cause our crops to wilt, and in less than two weeks the crop prospects may be nearly ruined as a result of the absence of the water needed to keep up a vigorous growth.

A rainfall of three inches per month, if fairly well distributed throughout the month, will probably produce an average growth of most farm crops. With less than this amount of rainfall many crops fail to make a normal development. During the past eight years the Storrs Experiment Station has made observations on rainfall during the growing season in about a dozen different places in the State, and from these and others made for the New England Meteorological Society are taken the following figures for the rainfall for the three summer months. From this table it will be seen that the rainfall has been below three inches for June, seven years out of eight; for July, three years; and for August, one year.

TABLE 70.

Rainfall in Connecticut during the summer months, 1888–95.

YEAR.	June.	July.	August.	Number of Stations.
	Inches.	Inches.	Inches.	
1888,	1.69	2.05	5.30	18
1889,	3.83	11.35	3.92	20
1890,	2.96	4.29	4.29	17
1891,	2.47	4.24	3.81	20
1892,	2.65	3.80	4.35	26
1893,	2.65	2.12	4.69	22
1894,	.75	1.55	1.81	23
1895,	2.74	4.36	4.54	21
Average,	2.47	4.22	4.09	—

The rainfall for the growing season (May to September), were it evenly distributed through the different months, would usually prove sufficient for the needs of most crops, but from the above table it will be seen that the rainfall for different months is very irregular. While the water which accumulates in the soil during the portions of the year when crops are not growing may be of some benefit to crops, yet a large part of the water used, especially where the ground water is quite a distance below the surface, must come from the rain that falls while the crops are growing. A remarkable instance of the excess of rainfall which often occurs when crops need the water least, and a deficiency during those months when crops use water most largely, is shown in the rainfall data at Storrs, Conn., for the year 1895. The five summer months, from May 1st to September 30th, showed a total rainfall of 14.5 inches, while the two succeeding months, October and November, gave a rainfall of 13.7 inches.

There are very few seasons during some part of which a drouth of more or less severity does not occur. With crops like strawberries, raspberries, early potatoes, and onions, a lack of rain for two or three weeks may lessen the crop by one-half or more. A striking illustration of the injury caused by short drouths was seen in the season of 1895, on one of the farms in this State where irrigation was being put into operation for the first time. A field of strawberries that had been set out in the spring of 1894 was on too high ground to be reached by water conducted from the storage pond. A field of the same size on another part of the farm was sprinkled from pipes

laid on the surface. The irrigated field, with only three applications of water, gave a yield two and two-thirds times greater than that obtained where no water was applied.

A strong argument in favor of irrigation in Connecticut is found in the high value per acre of many farm and garden crops. The following table shows the range of value per acre for some small fruits and market-garden crops as given by practical farmers, when these crops have not been irrigated:

Strawberries,	$200 to $450	Celery,	$200 to $300
Raspberries,	200 to 400	Onions,	150 to 300
Asparagus,	100 to 200	Muskmelons,	300
Cauliflower,	200 to 400		

It will readily be seen that a loss of one-half on some of these crops, when five or six acres are grown, would cover quite an outlay for water. The two men in Connecticut who have made the most extensive use of irrigation both state that the cost of the irrigation plant was returned the first season by the increased crops obtained where water was applied.

With crops like strawberries and raspberries the benefits derived from irrigation represent only a few weeks' labor and a small expenditure of money. So great is the gain derived from having an abundance of water for these crops at the right time that good profits have been obtained by the use of a road engine and force pump. In many places this form of power could be hired for a few days and large profits obtained from its use.

Before farming products were shipped by rail long distances the prices obtained for the crop in any locality depended largely upon the supply in that immediate vicinity. If the season was not a favorable one for any particular crop, and the yields were light, the increased prices obtained often counterbalanced the deficiency in the yield, so that the weather conditions did not so largely regulate the profits. To-day, however, if there is a shortage in any crop in one locality, the market, except in the case of perishable products, may be stocked from long distances away where the weather conditions were perhaps favorable for large yields. The profits obtained by local growers are thus largely dependent upon the seasons, and it frequently happens that the season of poor crops resulting from lack of rainfall nearly or quite uses up the profits of favorable seasons.

METHODS OF IRRIGATION IN USE IN CONNECTICUT.

The sources of water for irrigating purposes in Connecticut are mainly from small natural streams, from ponds, and from springs. No instances are known of the use of water from wells for irrigating purposes in this State. The water is usually stored either in open ponds or in large tanks. When the source is high enough the water is conducted on to the fields through open ditches or pipes, and this is, of course, the cheapest and simplest method. There are, however, many instances in Connecticut where the water can only be made available by some form of power, as it is below the fields upon which it is wanted. There are two farms in this State where powerful rams have been very successfully used; in such cases the water is generally conducted through, and distributed upon, the fields by means of pipes. Where a ram or other pumping appliance is used it is necessary, in order to reduce the expense, to economize on the use of water and to prevent losses by evaporation. For these reasons it has been found more economical to apply the water from pipes distributed over the fields, the water being sometimes allowed to flow between the rows from pipes laid along one end of the field. In other cases it is applied by spraying. Where the water is conducted to the field in ditches, as is successfully done in several instances in this State, it is distributed over the surface by means of small trenches.

RAMS.

Rams are one of the most economical sources of power for raising water. With the ram the pressure caused by a slight fall of the water from a canal or pond compresses the air in a heavy iron cylinder and this air pressure lifts the water. The amount of work a ram will do depends mainly upon the pressure of water. Considerable water must be available, as only a small portion of the total amount that passes into the ram can be pumped. The ram used on the farm of Mr. J. C. Eddy, of Simsbury, is one of as great capacity as any we have found; in fact this particular form is just being developed, none having as yet been put upon the market. It is run by a 6-inch drive pipe, the water having a fall of seven feet from the canal to the plunger. It lifts the water to a height of seventy feet

through a 2½-inch pipe, a distance of eighty rods, giving a flow into the storage pond of about ten gallons per minute. The only ram of similar capacity of which we have learned is manufactured by the Rife Co., of Roanoke, Va. The ram used by Mr. E. C. Warner, of North Haven, is a No. 10 Douglas Ram, manufactured at Middletown, Conn. This is run by a 6-inch drivepipe, the water falling seven feet to the plunger. It throws water into two large tanks at a height of sixty feet—600 feet distant—at the rate of five to six gallons per minute.

WINDMILLS.

Where only a comparatively small quantity of water is wanted, enough for a few acres at different times during the season, a windmill is perhaps the cheapest source of power, and will prove quite effectual. The storage can best be arranged for in a deep tank or cistern where the evaporation can be controlled by covering. The water can be distributed through pipes and applied by sprinkling, if the fall from the place of storage to the fields is enough to give good pressure.

FLOWAGE SYSTEM.

New England furnishes many conditions favorable for this system of irrigation. Among these may be mentioned the unevenness of the surface, the many small streams with considerable fall giving plenty of available water, and the fact that the terrace and alluvial soil formations of our river valleys are greatly benefited by irrigation. These alluvial and terrace formations are generally light soils with porous subsoils which suffer readily from drouth. Where this plan of irrigating is used in Connecticut the outlay is comparatively slight.

The expense for damming a small stream and thus getting a large storage pond is very light, and there are many places where the fall is favorable for conveying the water. Open ditches are used for conducting the water to the fields, and if the slope of the land to be irrigated is slight the water can be entirely distributed by small trenches. Some times streams that would be nearly or entirely dry late in the summer will furnish an abundance of water for such crops as strawberries and raspberries, grass and early potatoes, which require irrigating, if at all, before midsummer. In many cases the water

might also be utilized for furnishing power for cutting feed and sawing wood, and a conveniently located pond for getting ice in winter for the dairy and household, is a need felt by nearly all farmers.

IRRIGATION PLANTS IN USE IN CONNECTICUT.

There are several irrigation plants in active operation in this State at the present time, located in the towns of Simsbury, North Haven, Meriden, Glastonbury, Hamden, Thomaston, and South Manchester. These are the only ones known to the writer that are operated upon a commercial basis.

IRRIGATION ON THE FARM OF A. J. COE, MERIDEN.

Irrigation was commenced on Mr. Coe's farm by his father about the year 1840, the water being used for the next twenty years mainly upon the grass crop, although corn, potatoes, and other crops were irrigated whenever the rainfall was deficient. In 1863 Mr. Coe began to use the water on strawberries and raspberries, and has used it every year since whenever drouths seemed to make its use necessary. In 1895 he was using it on the two crops just mentioned, and upon tomatoes, asparagus, and cabbage.

The source of the water is a small stream, that, during seasons of average rainfall, would just about flow through a 6-inch pipe without pressure. The water is stored in two large ponds. The upper one is used mainly for getting ice for very large icehouses, and to supply power for cutting feed and wood. The smaller pond, a little lower down the stream, is so located that the water can be conducted through a ditch for a distance of about forty rods and then distributed over the field in small ditches. The amount of water is sufficient to thoroughly irrigate fifteen acres planted with a variety of crops, if none of them require very large quantities of water during short periods of time.

Mr. Coe has not been able to accurately estimate the profits obtained from irrigation, as the crops grown are used very largely for home consumption. Those sold go to local markets, which are often overstocked, and prices do not average as high as in some other cities. Mr. Coe, however, seemed thoroughly convinced that great profits may be obtained from irrigation where the expense for getting the water on to the land is not too great.

IRRIGATION ON THE FARM OF E. C. WARNER, NORTH HAVEN.

Mr. Warner began his irrigation operations about ten years ago, and has used the water mainly for strawberries and raspberries. The cultivated fields are so located that part of them may be watered by flowage from a pond supplied by springs and a small stream. Others are on high ground and may be watered from tanks located on a hill near by. A ram is used for filling these tanks, the source of the water being numerous small springs, the water of which, having been conveyed to a common point, makes a pond of about half an acre in area. A fall of six feet is obtained from the pond to the ram, and the water is lifted sixty feet in height, a distance of 600 feet to the tanks. As this system is essentially the same as that on the farm of Mr. Eddy, which is fully described further on, no detailed description is necessary. The water is mainly used directly from pipes, being sprinkled on the crops by means of hose.

On the west side of Mr. Warner's farm a small stream flows through a pasture, and by building small earth dams and ditches, the water is conveyed into a pond located a few feet higher than one of the strawberry fields. The fall along the rows of strawberries is very slight most of the distance, and the water is conducted across the rows near one end and turned down the rows as needed. At one point in the field there is a knoll so high that the water cannot be gotten on to a small area, but it is conducted around the knoll and then flows readily along the rows again, and over the rest of the field. Although no attempt was made to estimate the differences in yield, the crop obtained from this knoll was very much smaller, and the fruit of much poorer quality than over the rest of the field. The plants also were so much injured by the effects of the drouth that when seen in September they presented a striking contrast to the plants only a few feet away where the water had been used. The yield on this knoll was estimated to be only one-third as much as it was over the rest of the field, and Mr. Warner thinks that the crop on the whole field was double what it would have been had no artificial watering been done. The entire expense represented only a few days' work with men and teams, probably costing less than $25, when estimated at market rates of labor. So great

were the benefits derived from this small effort that Mr. Warner at once set about making plans to enlarge his system; and the past fall (1895), he has built a large storage pond, a little higher up the stream, where he expects to have storage capacity and water sufficient for four or five acres, all of which can be watered by direct flowage.

Mr. Warner has obtained very beneficial results from irrigation on raspberries. He has also used it to advantage upon peach trees in times of severe drouth during the fruiting season.

IRRIGATION ON THE FARM OF HALE BROS., SOUTH GLASTONBURY.

The Hale Bros., of South Glastonbury, extensive growers of fruit and nursery stock, have long felt the importance of irrigation in their business, and have been for some time maturing plans for utilizing a supply of water near their farm. They have been delayed in getting unrestricted legal rights to the water, but during the fall of 1895 were able to obtain control of the necessary supply, and have been laying out one of the largest, if not the largest, system of irrigation to be found in this State.

A small brook, which has never been known to go dry, has been dammed, and thus a reservoir formed. The source of the water is about 5,000 feet distant from the fields to be irrigated, and the fall about 100 feet. Heavy cast-iron pipe six inches in diameter, jointed together with lead, are used for 360 feet from the reservoir, and then a 4-inch pipe for 1,900 feet, or until a fall of fifty feet is obtained, after which the size of the pipe is reduced to three inches. The pipe is carried along the top of the ridges of the farm, and at points about 200 feet apart hydrants are placed, so that the water can be taken from the main pipe and used for surface flowage or for sprinkling. It is believed that there is sufficient water to thoroughly irrigate from forty-five to fifty acres of land, mainly by surface irrigation. The contour of the land and the character of the soil are such that water can be distributed between the rows of plants and trees, so as to give a very even distribution.

The Hale Bros. propose to use the water on small fruits, and ultimately on peaches. Mr. J. H. Hale is thoroughly convinced that the use of water on peach trees will prove profitable during

the fruiting time in seasons of severe drouth. An observation that he made several years ago may be of value as indicating the importance of a good water supply for this crop. At this particular time Mr. Hale had two large orchards, one on the home farm, and one about two miles away, both being upon soils of rather dry character. Shortly before the picking season began he made an estimate of the fruit that he expected to get from the two orchards. Very shortly after a severe thunder storm with drenching rains occurred at one of the orchards, but no rain fell at the other. Otherwise, the season was generally dry. At the end of the harvest he found that his estimate for the two orchards was just reversed in the crop actually obtained. In other words, the crop on the orchard which received the heavy rainfall was just about double the estimate, while the crop on the other orchard fell off one-half from the estimate.

IRRIGATION ON THE FARM OF JOSEPH ALBISTON, SOUTH MANCHESTER.

Mr. Albiston probably has the oldest irrigation plant in Connecticut. The privilege was granted in 1796, the water being taken from a small stream at a point about sixty rods above the limits of the farm. The stream is of sufficient size to about fill a 10 or 12-inch pipe in times of an average flow. The brook passes through part of the farm, and about seven acres of land either side of the stream can be watered. There are two small irrigation plants now in use on the farm. In the older the water is conveyed in an open ditch. The fall of the stream is such that at a very small expense for a dam practically all of the water can be turned into the ditch. About five acres can be watered by this means. This plant was very extensively used in irrigating grass for many years, fine crops being obtained each season, but during the past sixteen years Mr. Albiston has used it for small fruits and vegetables. Of the area watered from the canal, about three acres are nearly level, having a fall of less than five feet in 400 feet. The water can be conveyed by a branch ditch along one end of this area and then turned down between the rows of small fruits and vegetables as needed. About one acre, on quite a steep slope just below the main ditch, is thoroughly watered by seepage

from the canal, the water percolating through the soil a few feet below the surface for a distance of about four rods. This is a very peculiar and unusual condition, and cannot well be accounted for. It may be due to a hardpan bottom, which slopes nearly uniformly in the same direction as the surface.

A second plan of irrigation was adopted for a part of the farm a few years ago. At a point near where the same brook just referred to enters the farm a dam and small pond were constructed. The water of this pond is now used in the irrigating about two acres of the bottom land along the brook.

Most of the soil of the irrigated area is a gravelly loam, much of which has been washed down from the surrounding hills. About two acres of the bottom lands are of a more compact soil with a hardpan subsoil. This area has been underdrained and much improved. The surplus water used in irrigation is now readily conveyed away through the under drains.

Mr. Albiston has found the use of irrigation especially profitable on strawberries. Since he has irrigated this crop he rarely ever fails to obtain large yields, while before irrigation was employed he says failures from drouth were a common thing. In 1894, thirty-two square rods of land planted with Crescent strawberries produced at the rate of 10,400 quarts per acre. In 1895, with a very severe drouth in strawberry time, Mr. Albiston claims that his crop was the best that he ever produced. The black-cap raspberries and blackberries have each year produced exceptionally fine crops under irrigation. Potatoes have been irrigated during seasons of drouth. In 1894, which was an exceptionally unfavorable season for potatoes, the crop obtained by irrigation yielded at the rate of 300 bushels to the acre. Mr. Albiston is especially fortunate in being able to irrigate on quite an extended scale at a very small cost. Under conditions of this kind irrigation must pay a very fine profit.

IRRIGATION ON THE FARM OF JOHN LEEK, OF HAMDEN.

On this farm about five acres are under irrigation at the present time. The land is low, nearly level, lying between the slopes of hills, with a small stream of water passing through the irrigated area near the centre. The surface soil is a fine, gravelly loam that has apparently been washed in

from the surrounding hills. At a depth of about three feet is a gravelly clay hardpan, beneath which is a stiff clay. The land is naturally quite fertile, but a compact subsoil has prevented the escape of surplus water, while in case of drouths the land has baked and cracked badly. The physical condition of the soil has been greatly improved by drainage, and in case an excess of water is used in irrigating it will also readily pass off through the drain pipes. The texture of the soil is firm enough to prevent washing, and the fall is about three feet to one hundred, so the conditions are favorable for surface flowage from open ditches.

A small stream of water that would, in times of an average flow, readily pass through a 5-inch pipe, enters the farm through a narrow ravine and makes a fall of about twenty-five feet for the first thirty rods back from the irrigated area. About fifteen rods up this ravine has been built a dam and a small storage pond, from which the water is conveyed in open ditches to different parts of the field. The whole area has been laid out in three lots in such a way that water can be conveyed to the ends of the fields and allowed to run down between the rows of crops. The water has, in a small way, been used on a variety of garden crops, but quite extensively on strawberries and celery. Mr. Leek is so well pleased with the results on these crops that he is planning to enlarge his storage pond and to use the water more extensively in the future.

The conditions on this farm are similar to those found on many Connecticut farms, in that the water can be obtained for irrigation at a nominal cost. There are farms all through the State through which pass small streams having their source on higher ground near by, and all that is necessary to utilize the water is to build a storage pond and carry the water from this, by means of open ditches, to the lands to be irrigated.

IRRIGATION ON THE FARM OF W. A. LEIGH, THOMASTON.

This farm is located in the Naugatuck Valley, at the base of a bluff that rises, quite abruptly, some 350 feet above the valley. Over this bluff pours a small mountain stream that is quite constant, and of volume about sufficient to fill a 6-inch pipe in times of average flow. This stream is fed by springs

near the top of the bluff. By building a dam across a narrow ravine, 300 feet above the irrigated fields, a storage pond covering about five acres was formed. The water is conducted through a 3-inch pipe laid on the surface of the ground, and is used in furnishing power for a small granite works as well as for irrigating. The pressure is so great—about 125 pounds to the square inch—that a small stream runs a water-wheel furnishing seven horse-power. The water is mainly used at night for irrigating purposes.

For watering purposes, branch lines of respectively one and a-half and one-inch diameter pipe are laid on the surface of the ground some fifty feet apart. Short pieces of hose are attached to the line of pipe once in about fifty feet, and the water is applied by spraying through a ⅜-inch nozzle. The pressure is so great that three or four of these ⅜-inch streams may be kept "playing" from a single line of pipe at the same time. The water is forced to a great height and spreads over a large area, like a lively shower.

While Mr. Leigh has about eighteen acres upon which irrigation might be applied, its use has been confined to strawberries. Beginning in 1887, he has irrigated this crop every year since. In 1895 about three acres were under irrigation. The water is first applied about the time the plants bloom, and is continued till near the end of the fruiting season, if needed. Mr. Leigh prefers to use the water largely at night, as he claims it blackens or blights the leaves if applied near the middle of the day when the sun shines brightly. No accurate comparisons as to the yields with and without irrigation have been made, but Mr. Leigh estimates that double the crop has been obtained as a result of the free use of water.

IRRIGATION ON THE FARM OF J. C. EDDY, SIMSBURY.

Mr. Eddy is making a specialty of small fruits and vegetables, and the severe drouths which have occurred each summer for the past three or four years have forced upon his attention the importance, for the financial success of his business, of an abundance of water. The farm is located near the western limits of the Connecticut Valley, and is composed mainly of a light, porous, rather sandy soil that requires large quantities of water to grow crops successfully. A small stream,

within a narrow valley, passes through the farm, and the tillable lands lie mainly upon slopes just outside this valley. The water of the stream is not very cold, and the temperature is raised somewhat by allowing the water to stand in a storage pond, where a large surface is exposed to the direct rays of the sun. The water appears to contain quite a little organic matter, and doubtless furnishes considerable plant-food in addition to the direct effects of the water.

It was found impossible to get the water to other than a small portion of the farm by damming the stream and building ditches; and it would have cost quite a sum even then to have secured the "right of way," as the water would have had to be taken from a point beyond the limits of the farm. Some form of pumping appliance seemed to be the only feasible means of making the water available for irrigation, and a ram was adopted as the most practicable. In order to get the necessary fall for "running" the ram, a canal about forty rods in length was dug along the outer edge of the valley. From the lower end of this canal the water makes a fall of seven feet, through a 6-inch drive-pipe, and operates a large ram located near the centre of the valley. The water is turned into the canal by a small and inexpensive wooden dam. No more water is allowed to enter the canal than can be carried off through the drive-pipe of the ram. The supply that flows in the brook is many times the amount that even the heaviest form of ram could lift.

At quite an elevation above the cultivated fields, on soil of a heavy, clayey nature, was a small pond that usually became dry in summer. This was enlarged by dredging, and by building an earth dam on two sides. A storage pond was thus provided with an area of about half an acre and an average depth of about four feet, with a bottom tight enough to prevent much soakage. This pond is located about eighty rods from the stream, at the nearest point, and high enough to give good fall to most of the cultivated fields. The water has to be lifted to a height of seventy feet before it enters the storage pond. Connections can be made with this pipe at various points between the ram and the storage pond, and the water be thus used directly for irrigating certain areas. The main pipe used is two and one-half inches in diameter, and is laid

only sufficiently deep, so as not to interfere with cultivation. Mr. Eddy has been so successful in his operations during the past year that he proposes to enlarge his plant and to force the water over a large area of land on the opposite side of the valley from the storage pond. The contour lines show the amount of fall from the storage pond. The experiment plots the past two years are indicated by Ex. '95 and Ex. '96. The accompanying diagram will give a clear idea of the position of the ram, storage pond, and the various fields that can be watered.

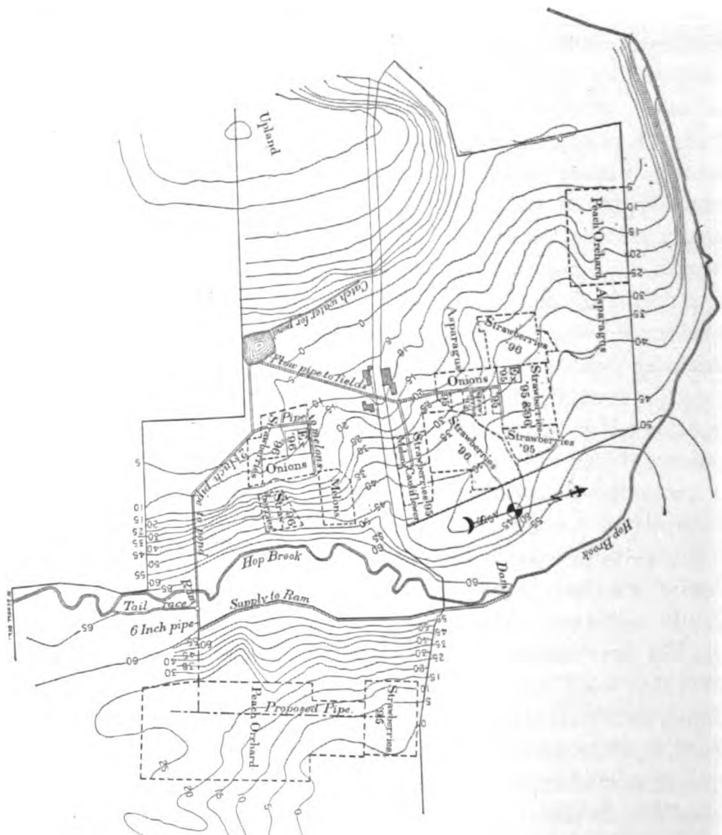


DIAGRAM OF THE FARM OF MR. J. C. EDDY, SIMSBURY, CONN.

(Published through the courtesy of the Office of Experiment Stations, U. S. Department of Agriculture.)

The fields to the north of the farm buildings are watered through pipes directly from the storage pond. Some difficulty has been experienced in getting a good flow, because air accumulated in the pipes where these ran over a slight elevation. By changing the course of the pipes a little Mr. Eddy found that he could avoid this difficulty and get a constant fall. The air might also be allowed to escape, under such conditions, by having a small petcock placed in the pipe at the highest point. Two acres of strawberries on the north side, which were irrigated during the season of 1895, were on land of such slope that either surface flowage or sprinkling could be used.

CROPS GROWN BY IRRIGATION ON FARM OF J. C. EDDY, SIMSBURY.

Strawberries, muskmelons, onions, and cauliflower were successfully grown by irrigation, by Mr. Eddy, during the past year (1895). These have proved especially important crops, because of their high value per acre, and the fact that the farm being located at quite a distance from markets, bulky crops giving smaller profits per acre would be expensive in handling. The variety of crops grown did not necessitate water in very heavy quantities at any one time during the season, unless, perhaps, for a few days during the fruiting season of the strawberries.

RESULTS OF IRRIGATION ON STRAWBERRIES.

Mr. Eddy had four acres of strawberries in 1895. Two of these were located on high ground at the east side of the farm, and could not be irrigated, and the other two on quite low ground north of the buildings to which pipes were laid for the water. A severe frost in May appeared to have destroyed many of the blossoms, and lessened the crop prospects very decidedly for the two acres located on low ground, while but little damage resulted to those on the high ground. Owing to this condition Mr. Eddy had expected to get larger returns from the field located on high ground, provided rainfall had been abundant. As it was, however, a drouth began early in June and seriously reduced the strawberry crop all over the State. At the end of the season Mr. Eddy found that the two acres which were not irrigated gave a yield of 150 crates (32 quarts each), while the two acres that

were irrigated yielded 415 crates. After the first few days picking the fruit on the non-irrigated field was much smaller and darker colored, and averaged only about eight cents a quart for the season, while that from the irrigated field averaged eleven cents a quart. It must be remembered, however, that the fruit from the non-irrigated field had to be sold when the markets were heavily stocked with berries, while much of that from the irrigated area reached the market after prices had risen, owing to the general shortage from the effects of the drouth.

The water was not applied until just before the picking season opened, although Mr. Eddy thinks better results would have been obtained had he begun to use the water two weeks earlier. The method of applying first adopted was surface flowage, but owing to the mulch between the rows it was found that this method was a very slow one. The mulch impeded the movement of the water, and often changed its course from between the two rows where the flow was started. For these reasons the plan of sprinkling from hose was adopted. Condemned 2-inch fire hose, with a large sprinkler, was used; this threw a powerful spray, covering an area about twenty feet in diameter. The pressure was sufficient to give a flow of thirty gallons per minute, with which it was found that one man could thoroughly water an acre in about ten hours. Later experience has shown that it is better to remove the mulch and allow the water to flow between the rows before the picking season opens, and then to replace the mulch if necessary.

RESULTS ON MUSKMELONS.

When grown on light soil and forced along rapidly early in the season, muskmelons have generally proved a very valuable crop in this State. Much loss, however, has been occasioned by frosts before considerable of the fruit was in condition to market. Mr. Eddy has found that by irrigating he has been able to get the melons into market considerably earlier than usual, and to get large crops before killing frosts come. As the plants only cover a small portion of the ground early in the season sprinkling seems to be the best method of applying the water, and where the soil is loose and porous, with considerable fall, sprinkling is, without doubt, the best method for

the entire season. By applying water once in five or six days, when a lack of rainfall seemed to make it necessary, Mr. Eddy finds he has been able to cause steady growth of the vines and to get a much larger yield than could have been obtained without artificial watering. There was much complaint as to the general quality of the fruit of muskmelons in the market in 1895, but Mr. Eddy says the flavor of his fruit was better than ever before, as attested by many of his customers. This may be a valuable feature of irrigation upon this crop; however, further experimenting will be necessary to establish this fact. The melon crop grown upon one acre by irrigation sold for $350, and the vines were "full of fruit" when they were killed by frost September 14.

ONIONS.

This crop did not suffer materially from drouth during 1895 in this State. Mr. Eddy's crop, however, was grown upon very light soil, and he had the ground thoroughly sprinkled once during the growing season. A small portion of the field could not be reached with the hose, and this was allowed to go without artificial watering. No measurements of the crop were made, but when visited by the writer, while the crop was being harvested, considerable difference could be seen between the crop on the irrigated land and that on the small strip which was not irrigated. One thing especially noticeable in addition to the smaller yield was the increased proportion of small onions where no water had been used.

CAULIFLOWER.

About one acre of this crop was grown during 1895. The crop was grown on a field of medium heavy loam only a few feet above the bottom lands of the valley. The fall across the field, lengthwise of the rows, was at the rate of three feet per hundred. From a 2½-inch pipe, with a 2-inch hose, about forty gallons of water per minute could be obtained, and only about eleven minutes were required for the water to flow from one end of the rows to the other, a distance of 175 feet. The water was applied once in about five or six days, if the lack of rainfall seemed to make it necessary. The cauliflower headed earlier than usual in 1895, and the crop sold readily at about $400 per acre.

EXPERIMENTS ON THE EFFECT OF IRRIGATION ON STRAWBERRIES.

In June, 1895, the Station began some experiments on the farm of Mr. J. C. Eddy, for the purpose of studying the effects of irrigation on the quantity and quality of strawberries, and to ascertain some facts regarding the profits to be obtained from the use of irrigation.

It is hoped that this will prove the beginning of a series of experiments in this State on the effects of irrigation on a variety of crops. There are many questions that it seems desirable to investigate in connection with the subject, such as the different methods of applying water and the relative advantage of each, observations on soil temperature, determinations of the amount of plant food supplied in the water used, and chemical analyses of fruits for the purpose of determining the amounts of sugar where the crop is irrigated or not irrigated. The work was undertaken so late in the season that observations were made only on the yield, and on the quality of the crop, as indicated by taste and appearance.

PLAN OF THE EXPERIMENT.

A section of about two acres was chosen from a field of strawberries. The soil appeared to be nearly uniform, and the conditions were favorable for applying the water. The field had been set to strawberries in the spring of 1894. The "Haverland" was the variety used, with every fourth plant in the row a "Jessie," the latter being used for fertilizing. The plots were laid out 115 feet long and twelve feet wide, three rows to a plot; two plots being irrigated and two not. Two rows were left between plots, which were not included in the experiment, in order to thoroughly separate the irrigated from the non-irrigated sections. The plots were to be irrigated as often as seemed to be necessary to get good commercial results.

RESULTS.

The following table gives the yields in quarts and pounds for each day when fruit was picked. The picking, by a representative of the Station, was done as often as seemed necessary to have the fruit in good marketable condition.

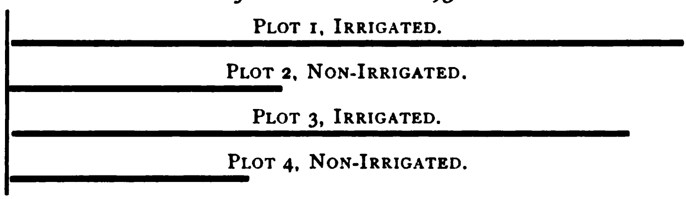
TABLE 71.

Irrigation on strawberries. Yields on irrigated and non-irrigated plots.

DATE.	Plot 1, Irrigated.		Plot 2, Non-Irrigated.		Plot 3, Irrigated.		Plot 4, Non-Irrigated.		When Watered.
1895.	Qts.	Lbs.	Qts.	Lbs.	Qts.	Lbs.	Qts.	Lbs.	Watered June 10.
June 13,	1.1	1.6*	4.0	5.6*	3.9	5.5*	3.0	4.2*	
June 14,	4.0	6.0*	6.0	8.4*	4.0	5.6*	6.0	8.4*	
June 15,	12.0	18.0*	12.0	16.8*	13.0	18.2*	6.5	9.1*	Watered.
June 17,	19.5	29.1	18.0	25.6	25.0	34.8	18.0	24.9	
June 18,	14.0	19.1	6.0	8.0	14.0	17.9	3.5	4.9	Watered.
June 19,	14.0	19.1	5.0	6.5	17.0	23.2	4.5	6.5	
June 20,	21.0	27.8	3.0	4.0	12.0	15.7	3.0	4.3	Watered part in eve. of 20th, balance early A. M. 21st.
June 21,	16.8	22.2	3.0	3.2	11.8	14.8	3.0	3.6	
June 22,	10.0	12.4	3.0	4.4	6.0	7.4	5.0	5.1	
June 24,	25.0	34.0	4.5	5.3	(†)	(†)	(†)	(†)	
June 25,	6.0‡	8.4‡	‡1.5	1.8	32.0	42.7	5.0	6.8	
June 26,	14.0	20.8	1.3	1.7	7.0	10.1	2.0	3.0	
June 27,	9.0	12.2	1.0	1.0	3.5	4.7	1.0	1.0	
June 28,	—	—	—	—	—	—	—	—	Rainy.
June 29,	4.0	5.5	1.0	1.1	3.5	4.9	1.0	1.4	
July 2,	5.5	7.9	0.5	0.8	6.0	8.3	0.5	0.9	
July 5,	2.0	2.4	—	—	1.0	1.4	—	—	
Total,	176.9	246.5	69.8	94.2	159.7	215.2	62.0	84.1	

* Assumed to weigh same rate per quart as on June 17.
† Not picked. ‡ Not all picked.

Comparative yields in quarts on irrigated and non-irrigated plots of strawberries 1895.



The yield on the two irrigated plots was at the rate of 5,318 quarts per acre; and on the two non-irrigated, at the rate of 2,083 quarts.

Water was used on the irrigated plots on June 10, 15, 18, and 20. The water was applied by means of 2-inch hose from a 2½-inch iron pipe laid on the surface of the ground. The size of the stream and the force of the water was sufficient to give thirty gallons (about one barrel) per minute. At this rate of flow one man could sprinkle about one acre per day. The ground was given a thorough wetting each time.

There was very little rainfall during the first twenty-five days of June. Seven-tenths of an inch fell between the 2d and 6th, but from the 6th to the 22d no rain whatever fell. On the 22d there was .25 inches, and after the 25th of the month rain was quite abundant. Strawberries, generally, began to feel the effects of the drouth by June 17th, before the picking season was more than one-third through.

It will be noticed that for the first two pickings the results were in favor of the non-irrigated plots, and that the yields on the non-irrigated plots were nearly as great as on the irrigated until after June 17. For the second picking (June 14), the two watered plots only gave eight quarts while the two not watered yielded twelve quarts. This tends to show that irrigation retards the development of the fruit and causes it to ripen a little later. Mr. Eddy noticed this same condition on his larger fields. During the first few pickings the fruit from the non-watered plots was noticed to be sweeter, but that from the watered plots were larger and "looked three cents per quart better."

On June 17th the leaves of the plants on the non-watered plots began to wilt quite badly and the berries to shrivel, and by the 18th the leaves were so dry as to break off, and the unripe fruit to shrivel and stop growing. The plants on the unwatered plots continued to dry, the leaves began to fall, and the fruit was small, dark colored, shriveled, and seedy.

On June 24th the writer visited the fields and made the following notes: "Plants on non-irrigated plots are drying badly. Leaves shriveled, and many dry and dead. Fruit small, dark colored when ripe, and shriveled and seedy. Hulls shriveled. Fruit looks over-ripe when picked. The darker color is probably due to the increased sunlight that the fruit gets, owing to the shriveled condition of the plants."

"Plants on the irrigated plots look fresh and vigorous; fruit large and abundant; much green fruit continuing to develop. Size of berries large, color bright. Fruit not quite as sweet as on the non-irrigated plots. Should judge the fruit from irrigated plots would sell for two to three cents per quart more than that from non-irrigated."

Mr. Eddy found that the fruit from the non-irrigated plots had to be sold for an average of nine cents per quart while that

from the irrigated areas brought eleven cents. At these rates per quart the fruit on the irrigated plots sold at the rate of $584.76 per acre, and that on the non-irrigated at the rate of $187.47 per acre, a difference of $397.29 per acre in favor of irrigation.

It will be readily seen that even with two acres of strawberries the increased returns obtained by the use of water would furnish quite a sum toward covering the expense of an irrigation plant.

SUGGESTIONS REGARDING IRRIGATION.

The contour of most of the land of Connecticut, and, in fact, of all New England, is such as to readily admit of the conveyance and application of water for irrigation. Streams, ponds, and springs are common and, except in cases of severe drouths, furnish an adequate supply of water. Many crops like strawberries, raspberries, and early vegetables need irrigating, if at all, early in the season, when the supply of water is often sufficient, while, perhaps, later in the season it would not be. Much of the land that would be improved by irrigation is in valleys, close to streams and ponds, which in many cases are high enough to give a moderate flow on the areas below, so the cost of getting the water would be merely nominal. The soils used for our most profitable crops are generally light and porous and leach water readily, but are just the kind that most need irrigating; while our best money crops, such as small fruits and vegetables, are heavy users of water. There is no need of drainage in connection with irrigation on soils of this class as is often the case where the surface soil is compact.

SOURCES OF WATER AND MEANS OF MAKING IT AVAILABLE.

The sources of water for irrigation in Connecticut are natural or artificial ponds, streams, and springs, and in some cases wells. In many cases ponds are so located that water can be conveyed from them to fields on lower ground by means of open ditches, the expense depending upon the distance and the character of the ground to be passed through. This is often the cheapest method for securing water. When the supply is large the loss of water occasioned by soakage from the ditch or evaporation is not of serious consequence. The fall of many of our small streams is so great that by building a small dam

the water may be turned from its natural course and conveyed in ditches along the outer edge of the valley and then allowed to flow over the surface of the fields back of the natural stream. A number of instances have come to our notice where the light alluvial soil of our valleys might thus be watered at small expense. In many cases the water could be taken from an old mill site and would be found sufficiently high to use for irrigation after it leaves the water-wheel. The water from several springs may some times be conveyed to a single point and then held in a small pond and the water drawn from this as needed. Where only small areas are to be irrigated wells may be made a source of water supply. The well must afford a large flow and should be so located that the water can be stored at some point at least twenty-five feet above the fields to be watered. In many cases bored wells might be utilized and afford a heavy flow of water.

PUMPING APPLIANCES.

Rams.—In many places in Connecticut the source of supply is below the fields to be irrigated and the water can only be made available by some pumping device. The cheapest sources of power are water and wind, although steam and electricity may be profitably used where the water is wanted only for a short period. A ram, under many conditions, is the best power. As only a small part of the water that is needed to operate the ram can be pumped, the supply must be quite large and the ram of heavy capacity. If the water is lifted over forty or fifty feet high the strain on the ram is quite severe and all the parts must be securely and strongly made. But few styles of rams manufactured in this country are powerful enough to supply water for anything but small areas (four to eight acres).

Windmills.—If wind is the form of power to be used the mill should be constructed of the best material, and be strong and secure in all its parts. Cheap forms of mills should be avoided in all cases. The best steel mills are the cheapest in the end. The mill should be located on high ground so it will "catch" the wind from all directions and so the place of storage may be sufficiently above the fields to be irrigated to give a good fall. The average velocity of the wind in New England is about twelve miles per hour. A 14-foot wheel will

do good work with a wind of ten to fifteen miles per hour. Of course the movement of the wind is very irregular, but there is usually sufficient to afford power to supply water for five to eight acres, by having a large storage tank. Wheels of large diameter are to be preferred in order to utilize light breezes.

Steam power.—When water is wanted for a short time on one or two crops which generally give good profits, some form of engine and pump may be economically used. The Wisconsin Experiment Station has watered a variety of crops in this way and has shown this method of irrigation to be a profitable one. By the use of a No. 4 Rotary Pump, driven by an 8-horse portable farm engine, Prof. King of that Station writes* that he has "drawn water through 110 feet of 6-inch suction pipe, raising the water to a height of 26 feet at the rate of 80,320 cubic feet per ton of soft coal, which is equivalent to 22½ inches of water per acre or over 7 acres covered to a depth of 3 inches. But this amount is much less than would have been moved with the same fuel had the pump been provided with a larger discharge and could the water have been used as rapidly as pumped so as to have made frequent stops unnecessary." For crops like strawberries, raspberries, and some vegetables which give large returns per acre and require water only for short periods of time, steam may be economically used as a source of power for pumping. On many farms a portable engine might be profitably rented for a few weeks during the strawberry season. This is a time when farm engines are seldom wanted for other purposes. Naphtha or gasoline engines of five to six horse-power are economical of fuel, can be easily operated, are of lighter weight than coal engines, and as a source of power they are worthy of careful consideration.

Electricity.—The recent wonderful developments in electricity point to that as one of our cheapest sources of power. Where such power is convenient we believe it can be economically used for pumping water for use on small fruits and some vegetables.

THE STORAGE OF WATER.

When the source of the water is below the fields to be irrigated some means of storage must be provided on high ground.

* "The Soil," page 274.

This may also be necessary in order to provide greater pressure, in cases where streams are utilized. If the supply of water is limited it will be found necessary to prevent waste as far as possible. This can best be done by storing the water in a tank or cemented reservoir, where but little evaporation and no loss by soakage can take place. If tanks are used they must be strongly built and of large capacity. Tanks of 15,000 to 20,000 gallons capacity are needed to supply water for five or six acres planted to a variety of crops.

Reservoirs.—Where large quantities of water are to be stored the open reservoir is the only practicable plan. If this is used in connection with some pumping appliance the losses by soakage and evaporation may be of serious consequence. These losses may be reduced if the bottom is of clay and the banks are so constructed as to avoid soakage. Loss by evaporation may be lessened by having the surface area small, while the desired capacity may be gotten by having a greater depth.

DISTRIBUTION AND APPLICATION OF WATER.

The oldest and most common method of distributing the water over the fields to be irrigated is by means of small ditches. These can be made by turning a furrow with a plow along the highest part of the field to be watered. By having a number of lines of these ditches parallel to each other along the slopes of the land the water may be let out on the lower side of the highest ditch and distributed over the land between this and the next ditch, while the second ditch will catch the surplus water. A man with a hoe removes obstructions and directs the water by opening small water courses. With a little attention the water can be made to touch nearly all parts of the field.

For crops like strawberries, when the water must be run between the rows, these should extend up and down the slope. Only a slight slope is needed to give free movement to the water; from three to six feet for every one hundred feet is better than a greater fall. With a heavy fall, and especially if the soil is sandy, serious washing will often result. In case mulch is used on strawberries it is found to interfere badly with the flow when the water is applied by surface flowage. If mulch is thought to be necessary to keep the fruit clean,

water should be applied freely just before the picking season begins and then the mulch applied. Prof. E. S. Goff, of the Wisconsin Experiment Station, has successfully used wooden troughs for distributing the water. These are made of rough boards ten and twelve inches wide, nailed together V-shaped, and are supported on stakes across the upper ends of the rows in such a way as to give a slight fall across the field. By means of small auger holes the water can be made to flow out between the rows. With small strips of tin, gates are made over these holes so that the amount of flow can be regulated.

If the water supply is limited iron pipes may advantageously be used in distributing the water to the points where needed. The water may either be allowed to flow from these over the surface or be applied by sprinkling. Unless the fall is very great (100 feet or more) these pipes should be at least two inches in diameter. If the distance is great and the fall does not exceed 100 feet there will be a serious loss of power by friction in case small pipes are used. Condemned fire hose two to three inches in diameter can be bought in most of our large cities, and if the fall from the reservoir or tank is fifty feet or more a heavy spray can be obtained by their use. A flow of twenty-five to forty gallons per minute seems to be necessary in using iron pipes and hose, in order to apply the water as rapidly as is desirable for strawberries.

In case a fall of 200 to 300 feet can be obtained, and the water can be conducted in pipes, it may be applied by means of lines of perforated pipes laid on wires over the fields. By this method very little labor is necessary as the water can be turned from one line of pipe into the next at pleasure. This method of irrigating strawberries was successfully carried on for a number of years by Dr. J. B. Learned, of Florence, Mass. The source of the water was the aqueduct supply of the town. Later the project had to be given up because the town needed all of the water for household and manufacturing purposes.

DIGESTION EXPERIMENTS WITH SHEEP.

BY C. S. PHELPS AND A. P. BRYANT.

One of the most important factors in the study of the laws of animal nutrition is the digestibility of the food. Only that portion of the food which is actually digested by the animal can be used for nutriment. Chemical analysis alone does not tell the nutritive value of the food, but the chemical composition taken in connection with actual digestion tests indicates quite accurately what portion of the food may be available for the nutrition of the animal. From experiments made elsewhere it has been found that differences of age, breed, and species of ruminants make comparatively slight differences in the proportions they digest from any given material. The digestibility of a feed by a sheep can be taken as a tolerably correct measure of its digestibility by a cow or steer. As sheep are easier to experiment with than the larger animals, and as many of the feeding experiments by the Station are with sheep, they have been employed in the digestion experiments which are here reported upon.

In order to learn more of the digestibility of feeding stuffs, and because of the need of digestion factors for use in connection with feeding experiments, the Station began in 1894 a series of digestion experiments with sheep. For a description of the method of conducting these experiments the reader is referred to the Annual Report of the Station for 1894, pages 107–109. It will suffice to say here that the feeding stuffs, the uneaten residues, and the feces were weighed and analyzed, and the differences between the amounts of organic matter and nutrients in the food eaten and in the feces were taken as the measure of the amounts digested. The sheep were kept in pens about five feet square, with mangers so arranged as to prevent loss of food by scattering. The feces were collected in rubber-lined bags. Each experiment lasted twelve days. The first

seven days were devoted to preliminary feeding, during which the feces were not collected and each animal had the run of its pen. At the end of the first seven days the sheep were placed in a narrow stall where they remained during the five days of the digestion experiment proper. In these experiments, as in those with men, the metabolic products in the feces are counted as if they were part of the undigested residue of the food. The heats of combustion of the food and feces were determined by the bomb calorimeter, and the results taken as the measure of the fuel value. The nitrogenous matter of the digested food is not completely oxidized in the body, but a portion is eliminated with the urine in urea and kindred compounds. The potential energy of these compounds does not become available to the body. Its amount is roughly calculated in the manner described on page 178, in the discussion under digestion experiments with men. The assumptions there made probably give rather too low results. Late research seems to indicate that a larger factor should be assigned for the fuel value of the nitrogenous matter of the urine. This subject is now being studied by the Station. Meanwhile the values here given may be considered as approximately correct.

General conclusions from these experiments will hardly be possible until more data are available. One point is, however, brought out very clearly. Among the feeding stuffs tested, those rich in protein, such as the legumes, are much more digestible than those with little protein, such as corn fodder, oat fodder, millet, and the like.

Table 72, which immediately follows, gives a summary of the results obtained in the digestion experiments thus far made with sheep by the Station. These experiments are arranged, according to the character of the feeding stuffs used, under the headings: milling products (with hay), cured fodders and hays, and green fodders and grasses. The details of experiments Nos. 1–9 will be found in the Annual Report for 1894, and Nos. 10–27 in the Report for 1895. The detailed account of the other experiments (Nos. 28–45) follow the summary table.

TABLE 72.

SUMMARY OF RESULTS OF DIGESTION EXPERIMENTS WITH SHEEP.

Percentages of total nutrients and of fuel value of nutrients actually digested.

FEEDING STUFFS.	Expt. No.	Sheep.	Protein. N. × 6.25.	Fat.	Nit.-free Extract.	Fiber.	Ash.	Organic Matter.	Fuel Value.
Milling Products (with Hay).			%	%	%	%	%	%	%
Bran, corn meal and hay,* -	1	B	48.0	60.6	71.5	45.6	5.9	62.7	57.6
Bran, corn meal and hay, -	1	D	62.1	72.9	76.1	59.6	26.6	70.8	66.4
Bran, corn meal and hay, -	4	B	57.6	69.1	80.1	60.7	32.0	72.8	67.9
Bran, corn meal and hay, -	4	D	52.2	71.2	77.7	55.2	27.4	69.6	65.2
Average, - - - - -	—	—	**55.0**	**68.5**	**76.4**	**55.3**	**23.0**	**69.0**	**64.3**
Bran, corn meal, linseed meal, oat and pea meal and hay,†	2	B	73.5	64.7	73.8	59.0	26.8	70.1	63.6
	2	D	71.2	71.2	74.9	60.8	28.2	70.9	64.8
Bran, corn meal, linseed meal, oat and pea meal and hay,	3	B	77.1	72.8	77.0	69.2	40.9	75.0	70.3
	3	D	71.6	73.4	73.6	61.1	20.9	70.3	65.4
Average, - - - - -	—	—	**73.4**	**70.5**	**74.8**	**62.5**	**29.2**	**71.6**	**66.0**
Soy bean meal and timothy hay,	12	A	75.8	71.1	66.7	61.2	42.0	68.5	62.9
Soy bean meal and timothy hay,	12	B	77.0	76.7	69.0	61.2	51.6	70.5	65.9
Soy bean meal and timothy hay,	12	C	80.0	77.4	68.4	63.1	48.9	71.5	67.0
Soy bean meal and timothy hay,	12	E	76.0	71.4	60.9	56.7	51.1	65.4	61.3
Average, - - - - -	—	—	**77.2**	**74.2**	**66.3**	**60.6**	**48.4**	**69.0**	**64.3**
Soy bean meal and timothy hay,	13	A	77.0	74.1	62.2	59.7	52.0	67.0	62.8
Soy bean meal and timothy hay,	13	B	77.4	73.3	66.5	63.1	36.8	69.5	64.0
Soy bean meal and timothy hay,	13	C	78.5	72.0	63.5	55.8	45.3	66.9	62.7
Soy bean meal and timothy hay,	13	E	80.0	73.1	71.8	69.5	48.6	73.7	68.7
Average, - - - - -	—	—	**78.2**	**73.1**	**66.0**	**62.0**	**45.7**	**69.3**	**64.6**
Experiment 12, calculated for digestibility of soy bean meal above average, - - -	—	—	85.1	86.6	73.6	—	26.3	77.5	72.2
Experiment 13, calculated for digestibility of soy bean meal above average, - - -	—	—	86.6	83.2	73.1	—	16.2	78.4	72.7
Average of experiments 12 and 13, eight tests, calculated for soy bean meal alone, - -	—	—	**85.8**	**84.9**	**73.4**	—	**21.3**	**78.0**	**72.5**
Coarse bran and rowen hay, mixed grasses, - - -	32	A	70.3	62.1	65.2	44.7	31.6	62.0	57.0
Coarse bran and rowen hay, mixed grasses, - - -	32	B	68.9	54.9	66.7	47.8	30.2	62.7	57.1
Coarse bran and rowen hay, mixed grasses, - - -	32	C	71.5	66.0	69.4	56.4	33.5	67.1	62.4
Coarse bran and rowen hay, mixed grasses, - - -	32	D	67.5	60.7	67.4	47.0	24.3	63.1	57.8
Average, - - - -	—	—	**69.6**	**60.9**	**67.2**	**49.0**	**29.9**	**63.7**	**58.6**
Experiment 32, calculated for digestibility of coarse bran, average, - - - -	—	—	**70.3**	**72.2**	**67.2**	**16.2**	**17.2**	**61.3**	**56.6**

* The wide ration of sheep feeding experiments, pp. 92-106, Report of 1894.

† The narrow ration of sheep feeding experiments, pp. 92-106, Report of 1894.

TABLE 72.—*(Continued.)*

FEEDING STUFFS.	Expt. No.	Sheep.	Protein. N. × 6.25.	Fat.	Nit.-free Extract.	Fiber.	Ash.	Organic Matter.	Fuel Value.
Milling Products (with Hay).			%	%	%	%	%	%	%
No. 2 wheat middlings and rowen hay, mixed grasses, -	33	A	73.9	71.7	71.0	54.4	41.7	68.5	63.9
No. 2 wheat middlings and rowen hay, mixed grasses, -	33	B	76.1	68.9	71.9	54.6	32.5	69.2	64.4
No. 2 wheat middlings and rowen hay, mixed grasses, -	33	C	70.9	71.7	73.0	54.3	28.8	69.1	63.7
No. 2 wheat middlings and rowen hay, mixed grasses, -	33	D	70.6	70.3	71.1	58.6	32.5	68.7	63.9
Average, - - - - -	—	—	**72.9**	**70.7**	**71.7**	**55.5**	**33.9**	**68.9**	**64.0**
Experiment 33, calculated for digestibility of No. 2 wheat middlings, average, - -	—	—	**75.7**	**88.8**	**75.6**	**30.2**	**25.0**	**71.3**	**67.3**
Cured Fodders and Hays.									
Rowen hay, mixed grasses, chiefly Kentucky blue grass,	8	A	70.1	50.5	67.7	66.2	54.8	66.7	60.9
	8	B	67.6	44.0	62.9	65.4	49.4	63.5	57.1
Rowen hay, mixed grasses, chiefly Kentucky blue grass,	8	C	70.2	45.6	62.6	66.1	55.5	64.1	58.1
	8	D	68.4	44.6	67.0	68.2	52.4	66.3	59.5
Average, - - - - -	—	—	**69.1**	**46.2**	**65.1**	**66.5**	**53.0**	**65.2**	**58.9**
Rowen hay, mostly timothy, -	9	A	66.1	50.8	64.9	65.2	50.8	64.4	59.3
Rowen hay, mostly timothy, -	9	B	69.4	48.2	60.9	62.0	74.6	62.0	58.6
Rowen hay, mostly timothy, -	9	C	68.2	48.7	63.5	65.2	53.2	64.1	58.3
Rowen hay, mostly timothy, -	9	D	68.3	50.3	64.3	73.4	46.9	67.2	60.9
Average, - - - - -	—	—	**68.0**	**49.5**	**63.4**	**66.5**	**56.4**	**64.4**	**59.3**
Rowen hay, mixed grasses, -	30	A	67.7	47.2	66.6	65.9	42.5	65.6	59.3
Rowen hay, mixed grasses, -	30	B	68.2	49.4	66.9	66.7	37.3	66.2	60.6
Rowen hay, mixed grasses, -	30	C	70.8	50.6	68.5	69.2	41.8	68.1	62.4
Rowen hay, mixed grasses, -	30	D	69.1	47.2	66.8	64.6	38.8	65.6	60.0
Average, - - - - -	—	—	**69.0**	**48.6**	**67.2**	**66.6**	**40.1**	**66.4**	**60.6**
Rowen hay, clover, field cured,	28	A	60.3	58.3	63.1	47.6	42.4	58.1	53.0
Rowen hay, clover, field cured,	28	B	65.1	60.4	64.1	50.7	45.8	60.5	54.5
Average, - - - - -	—	—	**62.7**	**59.4**	**63.6**	**49.1**	**44.1**	**59.3**	**53.8**
Rowen hay, clover, barn cured,	29	C	69.1	60.5	62.2	46.4	50.3	59.7	54.1
Rowen hay, clover, barn cured,	29	D	64.7	59.9	61.7	44.7	44.5	58.0	53.0
Average, - - - - -	—	—	**66.9**	**60.2**	**62.0**	**45.5**	**47.4**	**58.9**	**53.5**
Average field and barn cured (four tests), - - -	—	—	**64.8**	**59.8**	**62.8**	**47.4**	**45.7**	**59.1**	**53.7**
Scarlet clover hay, field cured,	10	A	67.8	49.2	59.4	39.8	48.4	52.9	48.3
Scarlet clover hay, field cured,	10	B	67.8	49.2	62.7	41.4	41.5	54.9	49.6
Scarlet clover hay, field cured,	10	C	68.9	45.9	57.3	46.4	46.8	54.8	50.3
Scarlet clover hay, field cured,	10	D	68.5	52.4	60.7	47.3	51.2	56.6	51.9
Average, - - - - -	—	—	**68.3**	**49.2**	**60.0**	**43.8**	**47.0**	**54.8**	**50.0**
Scarlet clover hay, barn cured,	11	A	67.2	32.8	59.8	47.0	45.6	56.2	50.0
Scarlet clover hay, barn cured,	11	B	67.6	29.5	61.6	48.9	47.2	57.6	51.6
Scarlet clover hay, barn cured,	11	C	73.2	42.3	63.9	42.8	49.7	57.8	52.1
Average, - - - - -	—	—	**69.3**	**34.9**	**61.8**	**46.2**	**47.5**	**57.2**	**51.2**
Average field and barn cured (seven tests), - - -	—	—	**68.7**	**43.0**	**60.8**	**44.8**	**47.2**	**55.8**	**50.5**

TABLE 72.—*(Continued.)*

FEEDING STUFFS.	Expt. No.	Sheep.	Protein. N. × 6.25	Fat.	Nit.-free Extract.	Fiber.	Ash.	Organic Matter.	Fuel Value.
Cured Fodders and Hays.			%	%	%	%	%	%	%
Oat hay (early seed), - -	31	A	52.3	60.5	52.3	45.6	19.6	50.7	46.6
Oat hay (early seed), - -	31	B	53.9	62.1	51.3	42.0	42.1	49.2	45.5
Oat hay (early seed), - -	31	C	57.7	63.0	53.9	46.8	41.7	52.6	48.9
Oat hay (early seed), - -	31	D	52.7	62.0	50.5	39.4	34.8	47.9	44.1
Average, - - - - -	—	—	**53.3**	**61.3**	**51.6**	**43.5**	**34.6**	**50.1**	**46.3**
Green Fodders and Grasses.									
Scarlet clover fodder, - -	5	A	76.7	67.3	74.5	54.1	55.0	68.5	63.7
Scarlet clover fodder, - -	5	B	77.5	62.9	74.9	57.9	55.9	69.8	64.3
Scarlet clover fodder, - -	5	D	77.2	69.3	74.1	56.2	57.4	69.1	64.3
Average, - - - - -	—	—	**77.1**	**66.5**	**74.5**	**56.1**	**56.1**	**69.1**	**64.1**
Barley fodder, - - - -	6	A	69.3	61.2	69.3	49.0	49.7	62.2	57.8
Barley fodder, - - - -	6	B	71.4	63.1	76.3	63.6	62.2	70.7	66.4
Barley fodder, - - - -	26	B	73.1	56.3	69.3	66.4	53.2	68.7	62.8
Barley fodder, - - - -	26	F	73.1	58.9	69.9	64.0	52.5	68.4	62.7
Average, - - - - -	—	—	**71.7**	**59.9**	**71.2**	**60.7**	**54.4**	**67.5**	**62.4**
Barley and pea fodder, - -	7	C	81.1	64.8	67.0	49.3	58.4	65.1	60.2
Barley and pea fodder, - -	7	D	73.2	54.5	55.8	37.6	33.9	55.2	49.4
Average, - - - - -	—	—	**77.2**	**59.7**	**61.4**	**43.5**	**46.2**	**60.2**	**54.8**
Oat and pea fodder, - -	14	A	81.7	74.3	65.7	61.2	38.5	68.7	63.9
Oat and pea fodder, - -	14	B	81.3	72.8	67.1	53.7	23.9	67.1	62.4
Oat and pea fodder, - -	35	D	73.2	70.3	66.9	49.1	41.9	62.9	59.9
Oat and pea fodder, - -	36	A	82.7	74.3	66.8	67.4	63.3	70.2	66.1
Oat and pea fodder, - -	36	B	76.5	65.1	56.2	60.2	54.4	61.7	57.3
Average, - - - - -	—	—	**79.1**	**71.4**	**64.5**	**58.3**	**44.4**	**66.1**	**61.9**
Oat fodder, - - - - -	15	C	75.7	68.4	63.5	62.6	43.8	65.4	61.9
Oat fodder, - - - - -	15	E	74.9	71.3	62.7	57.8	45.7	63.5	60.3
Oat fodder, - - - - -	34	A	67.8	67.5	61.1	43.5	49.1	56.5	53.2
Oat fodder, - - - - -	37	C	71.8	68.1	60.0	55.6	65.0	60.2	56.7
Oat fodder, - - - - -	37	D	72.8	72.3	66.9	53.6	67.9	63.3	59.6
Average, - - - - -	—	—	**72.6**	**69.5**	**62.3**	**54.6**	**54.3**	**61.8**	**58.3**
Barnyard millet fodder, - -	38	F	57.3	59.8	64.4	58.8	58.1	61.8	57.8
Barnyard millet fodder, - -	41	C	45.0	71.6	68.4	62.5	51.7	65.2	62.0
Barnyard millet fodder, - -	41	D	49.3	71.8	68.3	63.2	53.7	65.6	62.8
Average, - - - - -	—	—	**47.2**	**71.7**	**68.4**	**62.8**	**52.7**	**65.4**	**62.4**
Hungarian fodder, - - -	16	A	66.7	85.1	68.4	72.7	53.6	70.6	68.6
Hungarian fodder, - - -	16	B	71.8	81.9	71.7	76.1	62.9	73.8	71.3
Hungarian fodder, - - -	19	C	61.0	62.5	69.2	70.3	59.6	68.5	64.6
Hungarian fodder, - - -	19	D	61.6	59.8	66.3	72.2	57.8	67.6	63.6
Average, - - - - -	—	—	**65.3**	**72.3**	**68.9**	**72.8**	**58.5**	**70.1**	**67.0**
Soy bean fodder, - - -	17	C	80.5	58.2	70.9	44.7	1.8	64.5	61.2
Soy bean fodder, - - -	17	E	77.0	50.0	73.0	55.5	13.8	67.5	63.4
Soy bean fodder, - - -	20	B	70.8	59.3	71.7	38.5	27.6	61.0	56.1
Soy bean fodder, - - -	20	F	67.7	49.3	75.3	43.3	13.0	63.5	58.1
Soy bean fodder, - - -	39	C	77.8	54.3	73.0	45.5	27.9	63.2	57.0
Soy bean fodder, - - -	39	D	76.5	45.8	68.7	49.1	21.6	61.9	55.4
Soy bean fodder, - - -	40	B	74.4	61.5	77.4	49.2	29.0	67.5	62.8
Soy bean fodder, - - -	40	F	75.9	53.8	75.4	50.4	16.4	66.7	60.8
Average, - - - - -	—	—	**75.1**	**54.0**	**73.2**	**47.0**	**18.9**	**64.5**	**59.4**

TABLE 72.—*(Concluded.)*

FEEDING STUFFS.	Expt. No.	Sheep.	Protein. N. × 6.25.	Fat.	Nit.-free Extract.	Fiber.	Ash.	Organic Matter.	Fuel Value.
Green Fodders and Grasses.			%	%	%	%	%	%	%
Clover rowen,	18	B	61.4	60.0	63.9	51.5	42.7	59.7	55.6
Clover rowen,	18	F	62.3	61.5	66.7	53.6	44.1	61.9	57.3
Average,	—	—	**61.9**	**60.8**	**65.3**	**52.5**	**43.4**	**60.8**	**56.5**
Rowen, mixed grasses and clover,	44	B	64.9	56.3	71.9	61.8	44.2	67.0	61.3
Rowen, mixed grasses and clover,	44	F	69.9	54.0	71.3	63.3	48.1	67.8	62.3
Average,	—	—	**67.4**	**55.2**	**71.6**	**62.6**	**46.6**	**67.4**	**61.8**
Rowen, mostly timothy,	25	B	71.9	54.8	67.3	60.0	43.9	65.3	58.8
Rowen, mostly timothy,	25	F	71.5	50.9	68.2	67.6	46.5	67.5	61.7
Average,	—	—	**71.7**	**52.0**	**67.8**	**63.8**	**45.2**	**66.4**	**60.3**
Sweet corn fodder,	21	C	58.6	79.2	73.3	53.6	46.4	67.5	64.5
Sweet corn fodder,	21	D	52.5	77.3	74.9	54.9	54.9	68.4	65.4
Sweet corn fodder,	22	B	66.8	82.1	77.4	59.8	53.2	73.2	69.3
Sweet corn fodder,	22	F	66.1	81.3	79.1	61.6	47.4	74.5	70.5
Sweet corn fodder,	24	C	68.7	79.8	82.4	72.2	51.3	78.8	75.1
Sweet corn fodder,	24	D	57.9	76.2	75.9	57.9	49.4	70.4	66.2
Sweet corn fodder,	42	B	60.3	70.6	73.6	58.3	51.7	68.6	64.5
Sweet corn fodder,	42	F	61.1	72.1	73.4	60.5	54.3	69.1	65.1
Sweet corn fodder,	45	C	63.2	69.6	73.5	67.1	55.5	70.6	67.1
Sweet corn fodder,	45	D	57.9	71.0	73.8	58.6	61.0	68.2	64.6
Average,	—	—	**61.3**	**75.9**	**75.7**	**60.5**	**52.5**	**70.9**	**67.2**
Cow pea fodder,	23	C	72.7	62.5	84.2	57.8	28.2	75.9	71.2
Cow pea fodder,	23	D	75.3	56.3	84.2	57.1	19.5	76.0	70.9
Cow pea fodder,	43	C	77.3	60.0	76.4	62.4	19.9	72.1	66.1
Cow pea fodder,	43	D	77.0	58.6	77.5	61.0	23.2	72.1	66.3
Average,	—	—	**75.6**	**59.4**	**80.6**	**59.6**	**22.7**	**74.0**	**68.6**
Canada pea fodder,	27	C	81.1	50.0	71.3	62.4	37.8	71.0	64.3
Canada pea fodder,	27	D	83.0	54.8	70.8	62.4	46.9	71.7	65.0
Average,	—	—	**82.0**	**52.4**	**71.0**	**62.4**	**42.3**	**71.3**	**64.7**

DETAILED DESCRIPTION OF DIGESTION EXPERIMENTS WITH SHEEP, 1895–96.

The animals used in the following experiments were all wethers, dropped in the spring of 1893. Sheep A, C, D and F were grade Shropshires, and sheep B was a grade Merino. They were the same sheep that were used in the experiments of 1894–95. Experiments No. 28 and No. 29 were made on samples of clover rowen that came from a lot that was all cut at one time, the conditions being the same in all respects, except that the crop on half the area was hauled to the barn at once after cutting, and dried carefully by spreading thinly on a scaffold,

while the other portion was field cured in the usual way. The field-cured portion was dried by being spread thinly for three or four hours the day of cutting. It was then put into small heaps and left uncovered for two days, when it was spread and dried again for five or six hours, then put into heaps and covered, and left for six days, when it was aired and hauled. The hay seemed well cured. A slight sprinkle of rain fell while the hay was in heaps and covered.

DIGESTION EXPERIMENT NO. 28.

Clover rowen, field cured. A little past full bloom. The experiment began December 5, 1895, and continued twelve days. The feces were collected for the five days from December 12, at 6:45 A. M., to December 17, at 6:45 A. M. Each animal, sheep A and B, was fed daily 800 grams of the rowen. The experiment was normal throughout, the sheep eating vigorously.

DIGESTION EXPERIMENT NO. 29.

Clover rowen, barn cured. A little past full bloom. The experiment began December 5, 1895, and continued twelve days. The feces were collected for the five days from December 12, at 6:45 A. M., to December 17, at 6:45 A. M. Each animal, sheep C and D, was fed daily 800 grams of the rowen. The experiment was normal throughout, the sheep eating vigorously.

DIGESTION EXPERIMENT NO. 30.

Fine rowen of mixed grasses. The experiment began January 9, 1896, and continued twelve days. The feces were collected for the five days from January 16, at 6:45 A. M., to January 21, at 6:45 A. M. Each animal, sheep A, B, C and D, was fed daily 800 grams of the rowen, and all four went through the experiment nicely, eating full rations.

DIGESTION EXPERIMENT NO. 31.

Oat hay. This was a fair grade hay, nearly free from weeds and sharlock. The seeds were about two-thirds grown and did not shell. The experiment began January 31, 1896, and continued twelve days. The feces were collected for the five days from February 7, at 7 A. M., to February 12, at 7 A. M. Each animal, sheep A, B, C and D, was fed daily 800 grams of the hay. Sheep A, B and C left some uneaten butts, which were sampled, beginning with February 4. Sheep D also began later to leave uneaten butts, which were sampled from February 8.

DIGESTION EXPERIMENT NO. 32.

Coarse bran with fine rowen. The rowen was the same as was used in experiment No. 30. The experiment began February 19, 1896, and continued twelve days. The feces were collected for the five days from February 26, at 6:30 A. M., to March 2, at 6:30 A. M. Each animal, sheep A, B, C and D, was fed daily 400 grams of bran and 400 grams of rowen. The sheep had been fed for some days previous to commencing the experiment on bran and rowen in

different proportions to find the amounts best eaten. The experiment was normal throughout. Sheep A and B had no salt in their mangers the last eight days of the test. Sheep C and D had salt every day.

DIGESTION EXPERIMENT NO. 33.

No. 2 wheat middlings with fine rowen. The rowen was the same in this experiment as in No. 30 and No. 32. The experiment began March 25, 1896, and continued twelve days. The feces were collected for the five days from March 20, at 6:30 A. M., to March 25, at 6:30 A. M. Each animal, sheep A, B, C and D, was fed daily 400 grams of middlings and 400 grams of rowen. Everything was normal throughout the period.

DIGESTION EXPERIMENT NO. 34.

Oat fodder, fed green. This and the following experiments with green fodders were made particularly to test the digestibility of fodders used in feeding tests with milch cows. The general plan was to feed three days without sampling, then four days taking sample 1, then four days taking sample 2, then one day without sampling. This had at times to be modified to meet various conditions, particularly the weather. This experiment began July 7, 1896, and continued twelve days. The feces were collected for the five days from July 14, at 8:30 A. M., to July 19, at 8:30 A. M. Each animal, sheep A and B, was fed daily 2,740 grams of the fodder. The first sample was taken July 10. The oats were full size, seeds about half grown, stems large and slightly woody. The second sample was taken July 15. The oats were full grown and beginning to seed, some of the stems turning yellow and quite woody. Neither sheep ate full rations, and B left so much uneaten that he was dropped from the experiment. The experiment was repeated later with sheep C and D as No. 37. In this latter test less fodder was fed per day.

DIGESTION EXPERIMENT NO. 35.

Oat and pea fodder, fed green. The experiment began July 7, 1896, and continued twelve days. The feces were collected for the five days from July 14, at 8:30 A. M., to July 19, at 8:30 A. M. Each animal, sheep C and D, was fed daily 2,740 grams of the fodder. Two samples were taken, but one was lost. In the second sample, taken July 15, the oat stems were turning yellow and quite woody. The seed was about half grown. The peas were quite badly lodged and many stems blackened. There were few blossoms and many pods, some with seeds full grown. Neither sheep ate the full ration, and on account of the large amount of uneaten residue C was dropped from the experiment. This test was repeated later with sheep A and B as experiment No. 36, in which less fodder was fed per day.

DIGESTION EXPERIMENT NO. 36.

Oat and pea fodder, fed green. The experiment began July 20, 1896, and continued twelve days. The feces were collected for the five days from July 27, at 7 A. M., to August 1, at 7 A. M. Each animal, sheep A and B, was fed daily 2,340 grams of the fodder. At the time the first sample was taken, July 23, the oats were in the early milk stage. The peas were fairly succulent. Stems lodged and lower parts turned brown. Many pods and seeds developed. The second sample was lost. Both sheep ate full rations.

DIGESTION EXPERIMENT NO. 37.

Oat fodder, fed green. The experiment began July 20, 1896, and continued twelve days. The feces were collected for the five days from July 27, at 7 A. M., to August 1, at 7 A. M. Each animal, sheep C and D, was fed daily 2,340 grams of the fodder. At the time the first sample was taken, July 23, the oats were quite succulent, in early seed stage (watery). The second sample was taken July 27. The oats were in the early milk stage, quite green and succulent. Both sheep went through the test nicely, eating full rations.

DIGESTION EXPERIMENT NO. 38.

Millet fodder, fed green. The experiment began August 5, 1896, and continued twelve days. The feces were collected for the five days from August 12, at 6:30 A. M., to August 17, at 6:30 A. M. Each animal, sheep B and F, was fed daily 2,340 grams of the fodder. The first sample was taken August 8, the millet being in bloom, most of the heads grown, and quite succulent. The second sample, taken August 12, was from bloom to early seed stage, with stems slightly woody. Sheep F ate all his fodder, but B left some uneaten residue, which was sampled for the eight days from August 9 to 17.

DIGESTION EXPERIMENT NO. 39.

Soy bean fodder, fed green. The experiment began August 5, 1896, and continued twelve days. The feces were collected for the five days from August 12, at 6:30 A. M., to August 17, at 6:30 A. M. The first sample was taken August 8, when the beans were in early bloom and growing rapidly. At the time the second sample was taken, August 12, the beans were generally in bloom, but not full grown. Each animal, sheep C and D, was fed daily 2,340 grams of the fodder, and both ate full rations throughout the experiment.

DIGESTION EXPERIMENT NO. 40.

Soy bean fodder, fed green. The experiment began August 17, 1896, and continued fourteen days. The feces were collected for the seven days from August 24, at 6:30 A. M., to August 31, at 6:30 A. M. The fodder was from a second sowing. At the time of taking of the first sample, August 20, it was about two-thirds grown, in full bloom, with a few pods forming. The second sample, taken August 24, was mostly in bloom, and beginning to seed and quite succulent. The third sample was taken August 28. The beans were from bloom to early seed stage. Each animal, sheep B and F, was fed daily 2,340 grams of the fodder. During the first few days of the experiment sheep B left some of the leaves uneaten, but afterward ate full ration. For this reason the experiment was continued two days longer than usual, and the feces were collected for seven days. In the tables the experiment is calculated for five days to correspond with the others.

DIGESTION EXPERIMENT NO. 41.

Millet fodder, fed green. The experiment began August 19, 1896, and continued fourteen days. The feces were collected for the seven days from August 24, at 6:30 A. M., to August 31, at 6:30 A. M. The sample taken August 20

was in bloom to early seed stage, with rather woody stems. The second sample, taken August 24, was lost. A third sample was taken August 28. The millet was mostly in the early seed stage. Each animal, sheep C and D, was fed daily 2,340 grams of the fodder. Sheep C left some uneaten butts during the first part of the experiment, after which full rations were eaten. As in experiment No. 40, it was thought best to continue the experiment two days longer than usual, and the feces were collected for seven days. For the sake of comparison the results are calculated for five days.

DIGESTION EXPERIMENT NO. 42.

Sweet corn fodder, fed green. The experiment began August 31, 1896, and continued twelve days. The feces were collected for the five days from September 7, at 6:30 A. M., to September 12, at 6:30 A. M. The first sample was taken September 3. The corn was of the "Branching Sweet" variety. Many of the ears were in the roasting stage, some greener. The stalks were of good size and the proportion of ears large. The second sample was taken September 7. The ears were in the roasting stage and stalks quite succulent. Each animal, sheep B and F, was fed daily 2,740 grams of the fodder. For the first day or two only 2,340 grams were fed, but as the sheep seemed hungry the ration was increased. Both sheep went through the experiment nicely.

DIGESTION EXPERIMENT NO. 43.

Cow pea fodder, fed green. The experiment began August 31, 1896, and continued twelve days. The feces were collected for the five days from September 7, at 6:30 A. M., to September 12, at 6:30 A. M. Two samples were taken, one September 3, the other September 7. In the first the vines were about three-fourths grown, beginning to twine, and quite succulent. In the second the vines had attained a medium heavy growth, though not quite full grown, and were twining somewhat. Each animal, sheep C and D, was fed daily 2,340 grams of the fodder. The experiment seemed to be normal throughout.

DIGESTION EXPERIMENT NO. 44.

Rowen, mixed grasses and clover, fed green. The experiment began September 14, 1896, and continued twelve days. The feces were collected for the five days from September 21, at 6:30 A. M., to September 26, at 6:30 A. M. Two samples were taken, one September 17, the other September 21. In both the proportion of clover was about one-fifth; the grasses were fine. Each animal, sheep B and F, was fed 2,340 grams daily of the rowen.

DIGESTION EXPERIMENT NO. 45.

Sweet corn fodder, fed green. The experiment began September 14, 1896, and continued twelve days. The feces were collected for the five days from September 21, at 6:30 A. M., to September 26, at 6:30 A. M. Two samples were taken, the first September 17, the second September 21. The corn was of the "Branching Sweet" variety, as in experiment No. 42. In both samples the stalks were green and succulent, and the ears in the early roasting stage. Each animal, sheep C and D, was fed daily 2,740 grams of the fodder. The details of this experiment are omitted for lack of space, but the results are summarized in table 72, page 251.

DIGESTION EXPERIMENT No. 28.

Composition of feeding stuffs and feces.

Lab. No.		Water	Protein. N.×6.25.	Fat.	Nit.-free Ext	Fiber.	Ash.	Organic Matter.	Fuel Value.†
	Feeding Stuff.	%	%	%	%	%	%	%	Cal.
1622	Field-cured clover rowen, - -	15.1	15.7	3.6	37.4	21.0	7.2	77.7	3.841
	Feces.								
1609	Sheep A, - -	8.0	15.6	3.8	34.6	27.6	10.4	81.6	4.316
1610	Sheep B, - -	8.5	14.5	3.8	35.5	27.4	10.3	81.2	4.384

† Per gram as determined in calorimeter.

Weights of food eaten, and of feces for five days, and weights and percentages of nutrients digested.

	Total Weight.	Protein. N.×6.25.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Organic Matter.
Eaten in Five Days.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep A, - - - -	4000	628	144	1496	840	288	3108
Sheep B, - - - -	4000	628	144	1496	840	288	3108
Feces for Five Days.							
Sheep A, - - - -	1595	249	60	552	440	166	1301
Sheep B, - - - -	1512	219	57	537	414	156	1227
Amounts Digested.							
Sheep A, - - - -	—	379	84	944	400	122	1807
Sheep B, - - - -	—	409	87	959	426	132	1881
Percentage Digested.		%	%	%	%	%	%
Sheep A, - - - -	—	60.3	58.3	63.1	47.6	42.4	58.1
Sheep B, - - - -	—	65.1	60.4	64.1	50.7	45.8	60.5
Average, - - -	—	**62.7**	**59.4**	**63.6**	**49.1**	**44.1**	**59.3**

Fuel value of food for five days as determined by the bomb calorimeter.

	Fuel Val. of Food Eaten.	Fuel Val. of Feces.	Fuel Val. of Food Digested.	Fuel Val. of Urea, Etc.	Total Available Fuel Val.	Percent. Available Fuel Val.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep A, - -	15364	6884	8480	330	8150	53.0
Sheep B, - -	15364	6628	8736	356	8380	54.5
Average, - -	—	—	—	—	—	**53.8**

DIGESTION EXPERIMENT No. 29.

Composition of feeding stuffs and feces.

Lab. No.		Water	Protein. N.×6.25.	Fat.	Nit.-free Ext	Fiber.	Ash.	Organic Matter.	Fuel Value.†
	Feeding Stuff.	%	%	%	%	%	%	%	Cal.
1623	Barn-cured clover rowen, - -	14.6	17.4	3.8	37.2	19.7	7.3	78.1	3.903
	Feces.								
1611	Sheep C, - -	8.6	14.0	3.9	36.6	27.5	9.4	82.0	4.386
1612	Sheep D, - -	8.1	15.3	3.8	35.5	27.2	10.1	81.8	4.328

† Per gram as determined in calorimeter.

Weights of food eaten, and of feces for five days, and weights and percentages of nutrients digested.

	Total Weight.	Protein. N.×6.25.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Organic Matter.
Eaten in Five Days.	Grams.	Grams.	Grams	Grams.	Grams.	Grams.	Grams.
Sheep C, - - - -	4000	696	152	1488	788	292	3124
Sheep D, - - - -	4000	696	152	1488	788	292	3124
Feces for Five Days.							
Sheep C, - - - -	1537	215	60	563	422	145	1260
Sheep D, - - - -	1605	246	61	570	436	162	1313
Amounts Digested.							
Sheep C, - - - -	—	481	92	925	366	147	1864
Sheep D, - - - -	—	450	91	918	352	130	1811
Percentage Digested.		%	%	%	%	%	%
Sheep C, - - - -	—	69.1	60.5	62.2	46.4	50.3	59.7
Sheep D, - - - -	—	64.7	59.9	61.7	44.7	44.5	58.0
Average, - -	—	**66.9**	**60.2**	**61.9**	**45.6**	**47.4**	**58.9**

Fuel value of food for five days as determined by the bomb calorimeter.

	Fuel Val. of Food Eaten.	Fuel Val. of Feces.	Fuel Val. of Food Digested.	Fuel Val. of Urea, Etc.	Total Available Fuel Val.	Percent. Available Fuel Val.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep C, - -	15612	6741	8871	418	8453	54.1
Sheep D, - -	15612	6946	8666	392	8274	53.0
Average, - -	—	—	—	—	—	**53.6**

DIGESTION EXPERIMENT No. 30.

Composition of feeding stuffs and feces.

Lab. No.		Water	Protein. N.×6.25.	Fat.	Nit.-free Ext	Fiber.	Ash.	Organic Matter.	Fuel Value.†
	Feeding Stuff.	%	%	%	%	%	%	%	Cal.
1624	Rowen, - -	10.5	14.4	4.4	42.9	21.1	6.7	82.8	4.093
	Feces.								
1626	Sheep A, - -	6.6	13.4	6.7	41.4	20.8	11.1	82.3	4.561
1627	Sheep B, - -	5.6	13.4	6.5	41.6	20.6	12.3	82.1	4.477
1628	Sheep C, - -	5.3	13.1	6.8	42.3	20.3	12.2	82.5	4.537
1629	Sheep D, - -	4.8	13.0	6.8	41.6	21.8	12.0	83.2	4.527

† Per gram as determined in calorimeter.

Weights of food eaten, and of feces for five days, and weights and percentages of nutrients digested.

	Total Weight.	Protein. N.×6.25.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Organic Matter.
Eaten in Five Days.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep A, - - -	4000	576	176	1716	844	268	3312
Sheep B, - - -	4000	576	176	1716	844	268	3312
Sheep C, - - -	4000	576	176	1716	844	268	3312
Sheep D, - - -	4000	576	176	1716	844	268	3312
Feces for Five Days.							
Sheep A, - - -	1385	186	93	573	288	154	1140
Sheep B, - - -	1366	183	89	568	281	168	1121
Sheep C, - - -	1280	168	87	541	260	156	1056
Sheep D, - - -	1370	178	93	570	299	164	1140
Amounts Digested.							
Sheep A, - - -	—	390	83	1143	556	114	2172
Sheep B, - - -	—	393	87	1148	563	100	2191
Sheep C, - - -	—	408	89	1175	584	112	2256
Sheep D, - - -	—	398	83	1146	545	104	2172
Percentage Digested.		%	%	%	%	%	%
Sheep A, - - -	—	67.7	47.2	66.6	65.9	42.5	65.6
Sheep B, - - -	—	68.2	49.4	66.9	66.7	37.3	66.2
Sheep C, - - -	—	70.8	50.6	68.5	69.2	41.8	68.1
Sheep D, - - -	—	69.1	47.2	66.8	64.6	38.8	65.6
Average, - -	—	**69.0**	**48.6**	**67.2**	**66.6**	**40.1**	**66.4**

Fuel value of food for 5 days as determined by the bomb calorimeter.

	Fuel Val. of Food Eaten.	Fuel Val. of Feces.	Fuel Val. of Food Digested.	Fuel Val. of Urea, Etc.	Total Available Fuel Val.	Percent. Available Fuel Val.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep A, - -	16372	6316	10056	339	9717	59.3
Sheep B, - -	16372	6114	10258	342	9916	60.6
Sheep C, - -	16372	5806	10566	355	10211	62.4
Sheep D, - -	16372	6201	10171	347	9824	60.0
Average, - -	—	—	—	—	—	**60.6**

DIGESTION EXPERIMENT No. 31.

Composition of feeding stuffs and feces.

Lab. No.		Water	Protein. N.×6.25.	Fat.	Nit.-free Ext	Fiber.	Ash.	Organic Matter.	Fuel Value.†
	Feeding Stuff.	%	%	%	%	%	%	%	Cal.
1625	Oat hay,	12.3	9.8	4.1	42.5	25.8	5.5	82.2	4.033
	Feces.								
1630	Sheep A,	5.1	10.4	3.6	44.1	29.6	7.2	87.7	4.568
1631	Sheep B,	5.4	9.7	3.3	43.7	31.2	6.7	87.9	4.534
1632	Sheep C,	4.7	9.6	3.5	44.5	30.5	7.2	88.1	4.556
1633	Sheep D,	5.1	9.6	3.2	43.2	31.9	7.0	87.9	4.537
	Uneaten Residue.								
1640	Sheep A and D,	18.9	2.3	.9	26.9	27.4	23.6	57.5	2.716
1638	Sheep B,	7.8	4.4	2.7	40.9	38.2	6.0	86.2	4.143
1639	Sheep C,	10.7	2.8	1.2	38.6	40.1	6.6	82.7	3.942

† Per gram as determined in calorimeter.

Weights of food eaten, and of feces for five days, and weights and percentages of nutrients digested.

	Total Weight.	Protein. N.×6.25.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Organic Matter.
Eaten in Five Days.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep A, B, C, D, fed each	4000	392	164	1700	1032	220	3288
Uneaten residue, A,	261	6	2	70	72	62	150
Uneaten residue, B,	97	4	3	40	37	6	84
Uneaten residue, C,	130	4	2	50	52	9	108
Uneaten residue, D,	57	1	1	15	16	13	33
Actually eaten, A,	3739	386	162	1630	960	158	3138
Actually eaten, B,	3903	388	161	1660	995	214	3204
Actually eaten, C,	3870	388	162	1650	980	211	3180
Actually eaten, D,	3943	391	163	1685	1016	207	3255
Feces for Five Days.							
Sheep A,	1765	184	64	778	522	127	1548
Sheep B,	1850	179	61	809	577	124	1626
Sheep C,	1709	164	60	761	521	123	1506
Sheep D,	1930	185	62	834	616	135	1697
Amounts Digested.							
Sheep A,	—	202	98	852	438	31	1590
Sheep B,	—	209	100	851	418	90	1578
Sheep C,	—	224	102	889	459	88	1674
Sheep D,	—	206	101	851	400	72	1558
Percentage Digested.		%	%	%	%	%	%
Sheep A,	—	52.3	60.5	52.3	45.6	19.6	50.7
Sheep B,	—	53.9	62.1	51.3	42.0	42.1	49.2
Sheep C,	—	57.7	63.0	53.9	46.8	41.7	52.6
Sheep D,	—	52.7	62.0	50.5	39.4	34.8	47.9
Average,	—	**53.3**	**61.3**	**51.6**	**43.5**	**34.6**	**50.1**

Fuel value of food for 5 days as determined by the bomb calorimeter.

	Fuel Val. of Food Eaten.	Fuel Val. of Feces.	Fuel Val. of Food Digested.	Fuel Val. of Urea, Etc.	Total Available Fuel Val.	Percent. Available Fuel Val.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep A,	15423	8063	7360	176	7184	46.6
Sheep B,	15730	8388	7342	182	7160	45.5
Sheep C	15620	7786	7834	195	7639	48.9
Sheep D,	15977	8756	7221	179	7042	44.1
Average,	—	—	—	—	—	**46.3**

DIGESTION EXPERIMENT No. 32.

Composition of feeding stuffs and feces.

Lab. No.		Water	Protein. N.×6.25.	Fat.	Nit.-free Ext	Fiber.	Ash.	Organic Matter.	Fuel Value.†
	Feeding Stuff.	%	%	%	%	%	%	%	Cal.
1641	Rowen,*	13.2	13.5	4.9	40.2	20.7	7.5	79.3	3.985
1643	Coarse bran,	7.0	15.3	5.4	55.1	11.1	6.1	86.9	4.166
	Feces.								
1634	Sheep A,	5.7	11.1	5.1	43.1	22.9	12.1	82.2	4.326
1635	Sheep B,	5.9	11.8	6.1	41.8	21.9	12.5	81.6	4.376
1636	Sheep C,	5.6	12.1	5.2	43.2	20.5	13.4	81.0	4.267
1637	Sheep D,	7.4	12.1	5.2	40.2	21.8	13.3	79.3	4.234

* Same as in No. 30. † Per gram as determined in calorimeter.

Weights of food eaten, and of feces for five days, and weights and percentages of nutrients digested.

	Total Weight.	Protein. N.×6.25.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Organic Matter.
Eaten in Five Days.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep A,	4000	576	206	1906	636	272	3324
Sheep B,	4000	576	206	1906	636	272	3324
Sheep C,	4000	576	206	1906	636	272	3324
Sheep D,	4000	576	206	1906	636	272	3324
Feces for Five Days.							
Sheep A,	1538	171	78	663	352	186	1264
Sheep B,	1518	179	93	634	332	190	1238
Sheep C,	1352	164	70	584	277	181	1095
Sheep D,	1547	187	81	622	337	206	1227
Amounts Digested.							
Sheep A,	—	405	128	1243	284	86	2060
Sheep B,	—	397	113	1272	304	82	2086
Sheep C,	—	412	136	1322	359	91	2229
Sheep D,	—	389	125	1284	299	66	2097
Percentage Digested.		%	%	%	%	%	%
Sheep A,	—	70.3	62.1	65.2	44.7	31.6	62.0
Sheep B,	—	68.9	54.9	66.7	47.8	30.2	62.7
Sheep C,	—	71.5	66.0	69.4	56.4	33.5	67.1
Sheep D,	—	67.5	60.7	67.4	47.0	24.3	63.1
Average,	—	69.6	60.9	67.2	49.0	29.9	63.7

Fuel value of food for 5 days as determined by the bomb calorimeter.

	Fuel Val. of Food Eaten.	Fuel Val. of Feces.	Fuel Val. of Food Digested.	Fuel Val. of Urea, Etc.	Total Available Fuel Val.	Percent. Available Fuel Val.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep A,	16302	6653	9649	352	9297	57.0
Sheep B,	16302	6643	9659	347	9312	57.1
Sheep C,	16302	5769	10533	358	10175	62.4
Sheep D,	16302	6550	9752	339	9413	57.8
Average,	—	—	—	—	—	58.6

DIGESTION EXPERIMENT No. 33.

Composition of feeding stuffs and feces.

Lab. No.		Water	Protein. N.×6.25.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Organic Matter.	Fuel Value.†
	Feeding Stuff.	%	%	%	%	%	%	%	Cal.
1642	Rowen,*	8.8	13.1	4.8	44.3	22.0	7.0	84.2	4.131
1644	No. 2 wheat middlings,	8.4	18.7	5.8	52.5	9.6	5.0	86.6	4.210
	Feces.								
1645	Sheep A,	10.1	12.3	4.4	41.5	21.3	10.4	79.5	4.153
1646	Sheep B,	8.3	11.5	5.0	41.2	21.7	12.3	79.4	4.187
1647	Sheep C,	11.2	13.3	4.3	37.5	20.7	13.0	75.8	4.062
1648	Sheep D,	9.7	13.7	4.6	40.9	19.2	11.9	78.4	4.128

* Same as in Nos. 30 and 32. † Per gram as determined in calorimeter.

Weights of food eaten, and of feces for five days, and weights and percentages of nutrients digested.

	Total Weight.	Protein. N.×6.25.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Organic Matter.
Eaten in Five Days.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep A,	4000	636	212	1936	632	240	3416
Sheep B,	4000	636	212	1936	632	240	3416
Sheep C,	4000	636	212	1936	632	240	3416
Sheep D,	4000	636	212	1936	632	240	3416
Feces for Five Days.							
Sheep A,	1352	166	60	561	288	140	1075
Sheep B,	1322	152	66	545	287	162	1050
Sheep C,	1394	185	60	523	289	181	1057
Sheep D,	1366	187	63	559	262	162	1071
Amounts Digested.							
Sheep A,	—	470	152	1375	344	100	2341
Sheep B,	—	484	146	1391	345	78	2366
Sheep C,	—	451	152	1413	343	59	2359
Sheep D,	—	449	149	1377	370	78	2345
Percentages Digested.		%	%	%	%	%	%
Sheep A,	—	73.9	71.7	71.0	54.4	41.7	68.5
Sheep B,	—	76.1	68.9	71.9	54.6	32.5	69.2
Sheep C,	—	70.9	71.7	73.0	54.3	24.6	69.1
Sheep D,	—	70.6	70.3	71.1	58.6	32.5	68.7
Average,	—	**72.9**	**70.7**	**71.7**	**55.5**	**32.8**	**68.9**

Fuel value of food for 5 days as determined by the bomb calorimeter.

	Fuel Val. of Food Eaten.	Fuel Val. of Feces.	Fuel Val. of Food Digested.	Fuel Val. of Urea, Etc.	Total Available Fuel Val.	Percent. Available Fuel Val.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep A,	16682	5615	11067	409	10658	63.9
Sheep B,	16682	5535	11147	411	10736	64.4
Sheep C,	16682	5662	11020	390	10630	63.7
Sheep D,	16682	5639	11043	388	10655	63.9
Average,	—	—	—	—	—	**64.0**

DIGESTION EXPERIMENT No. 34.

Composition of feeding stuffs and feces.

Lab. No.		Water	Protein. N.×6.25.	Fat.	Nit.-free Ext	Fiber.	Ash.	Organic Matter.	Fuel Value.†
	Feeding Stuff.	%	%	%	%	%	%	%	Cal.
	Oat fodder:*								
1669	Sample 1, -	67.1	3.5	1.5	15.7	9.7	2.5	30.4	1.493
1670	Sample 2, -	67.0	3.0	1.5	16.3	9.9	2.3	30.7	1.474
	Average, -	**67.0**	**3.3**	**1.5**	**16.0**	**9.8**	**2.4**	**30.6**	**1.484**
	Feces.								
1678	Sheep A, - -	6.3	6.9	3.2	40.2	35.5	7.9	85.8	4.355
	Uneaten Residue.								
1789	Sheep A, - -	5.9	3.6	.9	36.0	46.6	7.0	87.1	4.092

* Fed green. † Per gram as determined in calorimeter.

Weights of food eaten, and of feces for five days, and weights and percentages of nutrients digested.

	Total Weight.	Protein. N.×6.25.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Organic Matter.
Eaten in Five Days.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep A, fed, - -	13700	452	206	2192	1343	329	4193
Uneaten residue, A, -	45	2	—	16	21	3	39
Actually eaten, A, -	13655	450	206	2176	1322	326	4154
Feces for Five Days.							
Sheep A, - - -	2104	145	67	846	747	166	1805
Amounts Digested.							
Sheep A, - - -	—	305	139	1330	575	160	2349
Percentage Digested.		%	%	%	%	%	%
Sheep A, - - -	—	67.8	67.5	61.1	43.5	49.1	56.5

Fuel value of food for 5 days as determined by the bomb calorimeter.

	Fuel Val. of Food Eaten.	Fuel Val. of Feces.	Fuel Val. of Food Digested.	Fuel Val. of Urea, Etc.	Total Available Fuel Val.	Percent. Available Fuel Val.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep A, - -	20147	9163	10984	265	10719	53.2

DIGESTION EXPERIMENT No. 35.

Composition of feeding stuffs and feces.

Lab. No.		Water	Protein. N.×6.25.	Fat.	Nit.-free Ext	Fiber.	Ash.	Organic Matter.	Fuel Value.†
	Feeding Stuff.	%	%	%	%	%	%	%	Cal.
1671	Oat & pea fodder,*	68.8	4.0	1.6	15.1	8.3	2.2	29.0	1.436
	Feces.								
1679	Sheep D, - -	6.6	8.3	3.7	38.7	32.8	9.9	83.5	4.268

* Fed green. † Per gram as determined in calorimeter.

Weights of food eaten, and of feces for five days, and weights and percentages of nutrients digested.

	Total Weight.	Protein. N.×6.25.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Organic Matter.
Eaten in Five Days.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep D, - - -	13700	548	219	2069	1137	301	3973
Feces for Five Days.							
Sheep D, - - -	1767	147	65	684	579	175	1475
Amounts Digested.							
Sheep D, - - -	—	401	154	1385	558	126	2498
Percentage Digested.		%	%	%	%	%	%
Sheep D, - - -	—	73.2	70.3	66.9	49.1	41.9	62.9

Fuel value of food for 5 days as determined by the bomb calorimeter.

	Fuel Val. of Food Eaten.	Fuel Val. of Feces.	Fuel Val. of Food Digested.	Fuel Val. of Urea, Etc.	Total Available Fuel Val.	Percent. Available Fuel Val.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep D, - -	19673	7541	12132	349	11783	59.9

DIGESTION EXPERIMENT No. 36.

Composition of feeding stuffs and feces.

Lab. No.		Water	Protein. N.×6.25.	Fat.	Nit.-free Ext	Fiber.	Ash.	Organic Matter.	Fuel Value.†
	Feeding Stuff.	%	%	%	%	%	%	%	Cal.
1672	Oat & pea fodder,*	71.4	4.7	1.3	10.6	10.0	2.0	26.6	1.312
1790	Uneaten residue, B,	6.4	19.9	2.0	38.3	27.4	6.0	87.6	4.190
	Feces.								
1680	Sheep A, - -	8.0	8.6	3.5	37.4	34.7	7.8	84.2	4.361
1681	Sheep B, - -	7.6	9.1	3.8	38.5	33.4	7.6	84.8	4.412

* Fed green. † Per gram as determined in the calorimeter.

Weights of food eaten, and of feces for five days, and weights and percentages of nutrients digested.

	Total Weight.	Protein. N.×6.25.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Organic Matter.
Eaten in Five Days.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep A, - - - -	11700	550	152	1240	1170	234	3112
Sheep B, - - - -	11700	550	152	1240	1170	234	3112
Uneaten residue, B, -	135	27	3	52	37	8	119
Actually eaten, A, -	11700	550	152	1240	1170	234	3112
Actually eaten, B, -	11565	523	149	1188	1133	226	2993
Feces for Five Days.							
Sheep A, - - -	1102	95	39	412	382	86	928
Sheep B, - - -	1351	123	52	520	451	103	1146
Amounts Digested.							
Sheep A, - - - -	—	455	113	828	788	148	2184
Sheep B, - - - -	—	400	97	668	682	123	1847
Percentage Digested.		%	%	%	%	%	%
Sheep A, - - - -	—	82.7	74.3	66.8	67.4	63.3	70.2
Sheep B, - - - -	—	76.5	65.1	56.2	60.2	54.4	61.7
Average, - -	—	79.6	69.7	61.5	63.8	58.9	66.0

Fuel value of food for 5 days as determined by the bomb calorimeter.

	Fuel Val. of Food Eaten.	Fuel Val. of Feces.	Fuel Val. of Food Digested.	Fuel Val. of Urea, Etc.	Total Available Fuel Val.	Percent. Available Fuel Val.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep A, - - -	15350	4806	10544	396	10148	66.1
Sheep B, - - -	14784	5961	8823	348	8475	57.3
Average, - -	—	—	—	—	—	61.7

DIGESTION EXPERIMENT No. 37.

Composition of feeding stuffs and feces.

Lab. No.		Water	Protein. N.×6.25.	Fat.	Nit.-free Ext	Fiber.	Ash.	Organic Matter.	Fuel Value.†
	Feeding Stuff.	%	%	%	%	%	%	%	Cal.
	Oat fodder:*								
1673	Sample 1,	74.0	2.6	1.1	11.7	8.4	2.2	23.8	1.162
1674	Sample 2,	73.0	2.8	1.2	12.7	8.2	2.1	24.9	1.215
	Average,	**73.5**	**2.7**	**1.2**	**12.2**	**8.3**	**2.1**	**24.4**	**1.189**
	Feces.								
1682	Sheep C,	6.5	6.8	3.4	43.7	33.0	6.6	86.9	4.459
1683	Sheep D,	7.1	7.1	3.2	38.9	37.1	6.6	86.3	4.451

* Fed green. † Per gram as determined in the calorimeter.

Weights of food eaten, and of feces for five days, and weights and percentages of nutrients digested.

	Total Weight.	Protein. N.×6.25.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Organic Matter.
Eaten in Five Days.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep C,	11700	316	141	1427	971	246	2855
Sheep D,	11700	316	141	1427	971	246	2855
Feces for Five Days.							
Sheep C,	1307	89	45	571	431	86	1136
Sheep D,	1216	86	39	473	451	80	1049
Amounts Digested.							
Sheep C,	—	227	96	856	540	160	1719
Sheep D,	—	230	102	954	520	166	1806
Percentages Digested.		%	%	%	%	%	%
Sheep C,	—	71.8	68.1	60.0	55.6	65.0	60.2
Sheep D,	—	72.8	72.3	66.9	53.6	67.9	63.3
Average,	—	**72.3**	**70.2**	**63.5**	**54.6**	**66.4**	**61.8**

Fuel value of food for 5 days as determined by the bomb calorimeter.

	Fuel Val. of Food Eaten.	Fuel Val. of Feces.	Fuel Val. of Food Digested.	Fuel Val. of Urea, Etc.	Total Available Fuel Val.	Percent. Available Fuel Val.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep C,	13910	5828	8082	197	7885	56.7
Sheep D,	13910	5412	8498	200	8298	59.6
Average,	—	—	—	—	—	**58.2**

DIGESTION EXPERIMENT No. 38.

Composition of feeding stuffs and feces.

Lab. No.		Water	Protein. N.×6.25.	Fat.	Nit.-free Ext	Fiber.	Ash.	Organic Matter.	Fuel Value.†
	Feeding Stuff.	%	%	%	%	%	%	%	Cal.
	Millet fodder:								
1696	Sample 1, -	75.6	1.7	.6	12.2	7.8	2.1	22.3	1.036
1675	Sample 2, -	75.5	2.0	.9	12.1	7.3	2.2	22.3	1.044
	Average, -	**75.6**	**1.8**	**.7**	**12.2**	**7.6**	**2.1**	**22.3**	**1.040**
	Feces.								
1685	Sheep F, - -	6.2	7.7	2.8	43.3	31.2	8.7	85.0	4.293

† Per gram as determined in calorimeter.

Weights of food eaten, and of feces for five days, and weights and percentages of nutrients digested.

	Total Weight.	Protein. N.×6.25.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Organic Matter.
Eaten in Five Days.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep F, - - - -	11700	211	82	1427	889	246	2609
Feces.							
Sheep F, - - - -	1173	90	33	508	366	103	997
Amounts Digested.							
Sheep F, - - - -	—	121	49	919	523	143	1612
Percentages Digested.		%	%	%	%	%	%
Sheep F, - - - -	—	57.3	59.8	64.4	58.8	58.1	61.8

Fuel value of food for 5 days as determined by the bomb calorimeter.

	Fuel Val. of Food Eaten.	Fuel Val. of Feces.	Fuel Val. of Food Digested.	Fuel Val. of Urea, Etc.	Total Available Fuel Val.	Percent. Available Fuel Val.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep F, - -	12168	5035	7133	105	7028	57.8

DIGESTION EXPERIMENT No. 39.

Composition of feeding stuffs and feces.

Lab. No.		Water	Protein. N.×6.25.	Fat.	Nit.-free Ext	Fiber.	Ash.	Organic Matter.	Fuel Value.†
	Feeding Stuff.	%	%	%	%	%	%	%	Cal.
	Soy bean fodder:*								
1697	Sample 1,	79.5	3.1	.7	8.0	6.4	2.3	18.2	.799
1698	Sample 2,	77.1	3.3	.9	8.7	7.6	2.4	20.5	1.010
	Average,	**78.3**	**3.2**	**.8**	**8.4**	**7.0**	**2.3**	**19.4**	**.905**
	Feces.								
1686	Sheep C,	5.0	7.6	4.0	24.4	41.1	17.9	77.1	3.967
1687	Sheep D,	4.8	7.8	4.5	27.3	36.9	18.7	76.5	3.962

* Fed green. † Per gram as determined in calorimeter.

Weights of food eaten, and of feces for five days, and weights and percentages of nutrients digested.

	Total Weight.	Protein. N.×6.25.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Organic Matter.
Eaten in Five Days.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep C,	11700	374	94	983	819	269	2270
Sheep D,	11700	374	94	983	819	269	2270
Feces for Five Days.							
Sheep C,	1085	83	43	265	446	194	837
Sheep D,	1129	88	51	308	417	211	864
Amounts Digested.							
Sheep C,	10615	291	51	718	373	75	1433
Sheep D,	10571	286	43	675	402	58	1406
Percentage Digested.		%	%	%	%	%	%
Sheep C,	—	77.8	54.3	73.0	45.5	27.9	63.2
Sheep D,	—	76.5	45.8	68.7	49.1	21.6	61.9
Average,	—	**77.2**	**50.1**	**70.9**	**47.3**	**24.8**	**62.6**

Fuel value of food for 5 days as determined by the bomb calorimeter.

	Fuel Val. of Food Eaten.	Fuel Val. of Feces.	Fuel Val. of Food Digested.	Fuel Val. of Urea, Etc.	Total Available Fuel Val.	Percent. Available Fuel Val.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep C,	10588	4304	6284	253	6031	57.0
Sheep D,	10588	4473	6115	249	5866	55.4
Average,	—	—	—	—	—	**56.2**

DIGESTION EXPERIMENT No. 40.

Composition of feeding stuffs and feces.

Lab. No.		Water	Protein. N.×6.25.	Fat.	Nit.-free Ext	Fiber.	Ash.	Organic Matter.	Fuel Value.†
	Feeding Stuff.	%	%	%	%	%	%	%	Cal.
	Soy bean fodder:*								
1676	Sample 1, -	76.0	3.8	1.2	10.6	6.0	2.4	21.6	1.053
1699	Sample 2, -	77.4	3.6	.9	8.6	7.2	2.3	20.3	.995
1700	Sample 3, -	75.8	2.7	.9	11.8	6.5	2.3	21.9	1.044
	Average, -	**76.4**	**3.4**	**1.0**	**10.3**	**6.6**	**2.3**	**21.3**	**1.031**
	Feces.								
1688	Sheep B, - -	5.1	9.6	4.3	25.8	37.1	18.1	76.8	4.008
1689	Sheep F, - -	5.0	8.7	4.8	26.7	34.5	20.3	74.7	4.018

* Fed green. † Per gram as determined in calorimeter.

Weights of food eaten, and of feces for five days, and weights and percentages of nutrients digested.

	Total Weight.	Protein. N.×6.25.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Organic Matter.
Eaten in Five Days.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep B, - - - -	11700	398	117	1205	772	269	2492
Sheep F, - - - -	11700	398	117	1205	772	269	2492
Feces for Five Days.							
Sheep B, - - - -	1056	102	45	272	392	191	811
Sheep F, - - - -	1110	96	54	296	383	225	829
Amounts Digested.							
Sheep B, - - - -	—	296	72	933	380	78	1681
Sheep F, - - - -	—	302	63	909	389	44	1663
Percentage Digested.		%	%	%	%	%	%
Sheep B, - - - -	—	74.4	61.5	77.4	49.2	29.0	67.5
Sheep F, - - - -	—	75.9	53.8	75.4	50.4	16.4	66.7
Average, - -	—	**75.2**	**57.7**	**76.4**	**49.8**	**22.7**	**67.1**

Fuel value of food for 5 days as determined by the bomb calorimeter.

	Fuel Val. of Food Eaten.	Fuel Val. of Feces.	Fuel Val. of Food Digested.	Fuel Val. of Urea, Etc.	Total Available Fuel Val.	Percent. Available Fuel Val.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep B, - -	12063	4232	7831	258	7573	62.8
Sheep F, - -	12063	4460	7603	263	7340	60.8
Average, - -	—	—	—	—	—	**61.8**

DIGESTION EXPERIMENT No. 41.

Composition of feeding stuffs and feces.

Lab. No.		Water	Protein. N.×6.25.	Fat.	Nit.-free Ext	Fiber.	Ash.	Organic Matter.	Fuel Value.†
	Feeding Stuff.	%	%	%	%	%	%	%	Cal.
	Barnyard millet:								
1677	Sample 1,	66.5	2.1	1.4	17.7	10.1	2.2	31.3	1.466
1701	Sample 2,	71.1	1.2	.7	15.8	9.2	2.0	26.9	1.243
	Average,	**68.8**	**1.7**	**1.0**	**16.8**	**9.6**	**2.1**	**29.1**	**1.355**
1791	Uneaten residue, C,	4.8	2.2	.9	51.2	33.8	7.1	88.1	3.972
	Feces.								
1690	Sheep C,	6.9	7.9	2.4	44.3	30.0	8.5	84.6	4.242
1691	Sheep D,	6.1	7.4	2.4	45.4	30.4	8.3	85.6	4.247

† Per gram as determined in calorimeter.

Weights of food eaten, and of feces for five days, and weights and percentages of nutrients digested.

	Total Weight.	Protein. N.×6.25.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Organic Matter.
Eaten in Five Days.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep C and D,	11700	199	117	1965	1123	246	3404
Uneaten residue, C,	57	1	1	29	19	4	50
Actually eaten:							
Sheep C,	11643	198	116	1936	1104	242	3354
Sheep D,	11700	199	117	1965	1123	246	3404
Feces for Five Days.							
Sheep C,	1380	109	33	611	414	117	1167
Sheep D,	1370	101	33	622	416	114	1172
Amounts Digested.							
Sheep C,	10263	89	83	1325	690	125	2187
Sheep D,	10330	98	84	1343	707	132	2232
Percentage Digested.		%	%	%	%	%	%
Sheep C,	—	45.0	71.6	68.4	62.5	51.7	65.2
Sheep D,	—	49.3	71.8	68.3	63.2	53.7	65.6
Average,	—	**47.2**	**71.7**	**68.4**	**62.8**	**52.7**	**65.4**

Fuel value of food for 5 days as determined by the bomb calorimeter.

	Fuel Val. of Food Eaten.	Fuel Val. of Feces.	Fuel Val. of Food Digested.	Fuel Val. of Urea, Etc.	Total Available Fuel Val.	Percent. Available Fuel Val.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep C,	15628	5854	9774	77	9697	62.0
Sheep D,	15854	5817	10037	85	9952	62.8
Average,	—	—	—	—	—	**62.4**

DIGESTION EXPERIMENT No. 42.

Composition of feeding stuffs and feces.

Lab. No.		Water	Protein. N.×6.25.	Fat.	Nit.-free Ext	Fiber.	Ash.	Organic Matter.	Fuel Value.†
	Feeding Stuff.	%	%	%	%	%	%	%	Cal.
	Sweet corn fodder:*								
1727	Sample 1, -	79.4	2.0	.5	12.2	4.7	1.2	19.4	.911
1702	Sample 2, -	82.7	1.7	.5	10.4	3.6	1.1	16.2	.750
	Average, -	**81.1**	**1.8**	**.5**	**11.3**	**4.2**	**1.1**	**17.8**	**.831**
	Feces.								
1692	Sheep B, - -	6.6	10.9	2.2	45.5	26.7	8.1	85.3	4.361
1693	Sheep F, - -	6.9	10.9	2.1	46.6	25.7	7.8	85.3	4.351

* Fed green. † Per gram as determined in calorimeter.

Weights of food eaten, and of feces for five days, and weights and percentages of nutrients digested.

	Total Weight.	Protein. N.×6.25.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Organic Matter.
Eaten in Five Days.	Grams.	Grams.	Grams	Grams.	Grams.	Grams.	Grams.
Sheep B, - - -	13700	247	68	1548	575	151	2438
Sheep F, - - -	13700	247	68	1548	575	151	2438
Feces for Five Days.							
Sheep B, - - -	898	98	20	408	240	73	766
Sheep F, - - -	884	96	19	412	227	69	754
Amounts Digested.							
Sheep B, - - -	—	149	48	1140	335	78	1672
Sheep F, - - -	—	151	49	1136	348	82	1684
Percentage Digested.		%	%	%	%	%	%
Sheep B, - - -	—	60.3	70.6	73.6	58.3	51.7	68.6
Sheep F, - - -	—	61.1	72.1	73.4	60.5	54.3	69.1
Average, - -	—	**60.7**	**71.4**	**73.5**	**59.4**	**53.0**	**68.9**

Fuel value of food for 5 days as determined by the bomb calorimeter.

	Fuel Val. of Food Eaten.	Fuel Val. of Feces.	Fuel Val. of Food Digested.	Fuel Val. of Urea, Etc.	Total Available Fuel Val.	Percent. Available Fuel Val.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep B, - -	11385	3916	7469	130	7339	64.5
Sheep F, - -	11385	3841	7539	131	7408	65.1
Average, - -	—	—	—	—	—	**64.8**

DIGESTION EXPERIMENT No. 43.

Composition of feeding stuffs and feces.

Lab. No.		Water	Protein. N.×6.25.	Fat.	Nit.-free Ext	Fiber.	Ash.	Organic Matter.	Fuel Value.†
	Feeding Stuff.	%	%	%	%	%	%	%	Cal.
	Cow pea fodder:*								
1705	Sample 1, -	84.7	3.0	.6	6.3	3.6	1.8	13.5	.643
1703	Sample 2, -	84.0	2.8	.6	6.9	3.8	1.9	14.1	.663
	Average, -	**84.4**	**2.9**	**.6**	**6.6**	**3.7**	**1.8**	**13.8**	**.653**
	Feces.								
1694	Sheep C, - -	5.6	11.7	4.2	27.8	24.9	25.8	68.6	3.600
1695	Sheep D, - -	4.8	12.1	4.6	27.0	26.3	25.2	70.0	3.653

* Fed green. † Per gram as determined in calorimeter.

Weights of food eaten, and of feces for five days, and weights and percentages of nutrients digested.

	Total Weight.	Protein. N.×6.25.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Organic Matter.
Eaten in Five Days.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep C, - - -	11700	339	70	772	433	211	1614
Sheep D, - - -	11700	339	70	772	433	211	1614
Feces for Five Days.							
Sheep C, - - -	656	77	28	182	163	169	450
Sheep D, - - -	643	78	29	174	169	162	450
Amounts Digested.							
Sheep C, - - -	—	262	42	590	270	42	1164
Sheep D, - - -	—	261	41	598	264	49	1164
Percentage Digested.		%	%	%	%	%	%
Sheep C, - - -	—	77.3	60.0	76.4	62.4	19.9	72.1
Sheep D, - - -	—	77.0	58.6	77.5	61.0	23.2	72.1
Average, - -	—	**77.2**	**59.3**	**77.0**	**61.7**	**21.6**	**72.1**

Fuel value of food for 5 days as determined by the bomb calorimeter.

	Fuel Val. of Food Eaten.	Fuel Val. of Feces.	Fuel Val. of Food Digested.	Fuel Val. of Urea, Etc.	Total Available Fuel Val.	Percent. Available Fuel Val.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep C, - -	7640	2362	5278	228	5050	66.1
Sheep D, - -	7640	2349	5291	227	5064	66.3
Average, - -	—	—	—	—	—	**66.2**

DIGESTION EXPERIMENT No. 44.

Composition of feeding stuffs and feces.

Lab. No.		Water	Protein. N.×6.25.	Fat.	Nit.-free Ext	Fiber.	Ash.	Organic Matter.	Fuel Value.†
	Feeding Stuff.	%	%	%	%	%	%	%	Cal.
	Rowen:								
1704	Sample 1, -	75.7	3.5	1.4	11.3	6.2	1.9	22.4	1.105
1728	Sample 2, -	70.2	4.0	1.6	13.6	8.1	2.5	27.3	1.350
	Average, -	72.9	3.8	1.5	12.5	7.1	2.2	24.9	1.228
	Feces.								
1732	Sheep B, - -	8.4	12.9	6.4	34.1	26.3	11.9	79.7	4.400
1733	Sheep F, - -	8.1	11.5	6.9	35.9	26.1	11.5	80.4	4.401

† Per gram as determined in calorimeter.

Weights of food eaten, and of feces for five days, and weights and percentages of nutrients digested.

	Total Weight.	Protein. N.×6.25.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Organic Matter.
Eaten in Five Days.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep B, - - - -	11700	445	176	1462	830	258	2913
Sheep F, - - - -	11700	445	176	1462	830	258	2913
Feces for Five Days.							
Sheep B, - - - -	1206	156	77	411	317	144	961
Sheep F, - - - -	1168	134	81	419	305	134	939
Amounts Digested.							
Sheep B, - - - -	—	289	99	1051	513	114	1952
Sheep F, - - - -	—	311	95	1043	525	124	1974
Percentage Digested.		%	%	%	%	%	%
Sheep B, - - - -	—	64.9	56.3	71.9	61.8	44.2	67.0
Sheep F, - - - -	—	69.9	54.0	71.3	63.3	48.1	67.8
Average, - -	—	67.4	55.2	71.6	62.6	46.2	67.4

Fuel value of food for 5 days as determined by the bomb calorimeter.

	Fuel Val. of Food Eaten.	Fuel Val. of Feces.	Fuel Val. of Food Digested.	Fuel Val. of Urea, Etc.	Total Available Fuel Val.	Percent. Available Fuel Val.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep B, - -	14368	5306	9062	251	8811	61.3
Sheep F, - -	14368	5140	9228	271	8957	62.3
Average, - -	—	—	—	—	—	61.8

ANALYSES OF FODDERS AND FEEDING STUFFS.

REPORTED BY W. O. ATWATER AND F. G. BENEDICT.

In connection with the work of the Station during the year, analyses of the following miscellaneous feeding stuffs have been made by the Station chemists. Most of the analyses were made in connection with feeding experiments or experiments upon the growth of plants. In no case were they undertaken merely to increase the amount of data of this class. The method of analysis were those recommended by the Association of Official Agricultural Chemists.

The results of the analyses as calculated to water content at harvest or at the time of analyses are given in table 73, page 280, which follows the description of samples. In this table the materials are grouped somewhat according to their water content at time of taking samples, as follows: Green fodders; silage; cured hay and fodder; grain; and milling products. This order is also observed in the description of samples.

The results calculated to water-free substance (dry matter) as the basis are given in table 74, page 284.

The fuel value of a pound of each of the feeding stuffs as given in the tables was obtained by multiplying the number of hundredths of a pound of protein and of carbohydrates by 18.6, and the number of hundredths of a pound of fat by 42.2, and taking the sum of these three products as the number of calories of potential energy in the materials.

The heats of combustion of the majority of the specimens were also made with the bomb calorimeter. The results of a large number of these determinations have been given in the tabular statements included in the accounts of feeding and digestion experiments with sheep. A compilation of the work of the Station in this field is now being made for publication.

There are two sets of averages given in tables 73 and 74 beyond: the first is the average of the samples analyzed during the past year; the second is the average of all analyses of similar foods made up to the present time in this laboratory.

DESCRIPTION OF SAMPLES.

ANALYSES OF DISTINCT SPECIES OF GRASSES GROWN WITH DIFFERENT QUANTITIES OF FERTILIZERS.

In the year 1892 the Station began a series of experiments on the effect of nitrogenous and of mineral fertilizers on pure species of grasses, which were grown upon small plots (one-eightieth acre each) in the grass garden. The grasses were grown in drills and were kept as free as possible from admixtures of weeds or of other grasses. The experiment was continued for three years. In 1894 it was noticed that many of the plots, especially those having mineral fertilizers only, produced a large proportion of clover, making it difficult to sample the grasses and have the samples pure. Sorrel and other small weeds were also filling up the drills, and it was thought best to remove the grasses and to cultivate and re-seed. This was done in August, 1894. In the spring of 1895 it was noticed that some of the plots were not well stocked. The vacant places were filled out, either by transplanting or by sowing more seed, and the experiment was discontinued for that year, except that the same kinds and quantities of fertilizers were used, but no samples were taken for analysis.

In the spring of 1896 the drills of grasses were found to be well stocked, and the experiment was renewed. The samples of timothy, orchard grass, and meadow fescue described below represent the fifth annual crop grown on plots which had the same kinds and amounts of fertilizers each year, while the brome grass and red-top represent the second annual crop.

GREEN FODDER.

1649, 1654, 1659, 1664 *Timothy (Phleum pratense).*—Grown in the Station grass garden in 1896. The samples were taken July 14, at which time the seed was beginning to form and the stems were fairly succulent. No. 1649 was from a plot without fertilizer. The growth was light, thin, and of a pale color. No. 1654 was from a plot to which was applied dissolved bone-black at the rate of 320 pounds an acre, and muriate of potash at the rate of 160 pounds. Growth very similar to that on 1649. No. 1659 was from a plot which had dissolved bone-black and muriate of potash the same as 1654, and in addition nitrate of soda at the rate of 160 pounds per acre. The growth was heavy and of fair color. No. 1664 was from a plot which had dissolved bone-black and muriate of potash the same as 1654, and in addition nitrate of soda at the rate of 480 pounds per acre. There was a much larger crop than on the other plots, with thick bottom and heavy leaf growth.

1650, 1655, 1660, 1665, *Orchard grass (Dactylis glomerata)*.—Grown in the Station grass garden in 1896. The samples were taken June 30, in the early seed stage. The stems were somewhat woody. No. 1650 was from a plot to which no fertilizer was applied. The growth was thin, light, and pale colored. No. 1655 was from a plot to which was applied dissolved bone-black at the rate of 320 pounds, and muriate of potash at the rate of 160 pounds per acre. Growth only slightly heavier than on 1650. No. 1660 was from a plot which had dissolved bone-black and muriate of potash at the same rate as 1655, and in addition nitrate of soda at the rate of 160 pounds per acre. The growth was medium heavy, thick, and of fair color. No. 1665 was from a plot which had dissolved bone-black and muriate of potash at the same rate as 1655, and in addition nitrate of soda at the rate of 480 pounds per acre. There was a heavy, dense growth, of good color, and a large proportion of leafy, bottom growth.

1651, 1656, 1661, 1666, *Meadow fescue (Festuca elatior)*.—Grown in the Station grass garden in 1896. The samples were taken June 30, in the early seed stage. Stems slightly woody. No. 1651 was from a plot which had no fertilizer. The growth was slight, thin and spindled, and of pale color. No. 1656 was from a plot which had dissolved bone-black at the rate of 320 pounds per acre, and muriate of potash at the rate of 160 pounds. A slightly heavier growth than on 1651, but of pale yellow. No. 1661 was from a plot which had dissolved bone-black and muriate of potash at the same rate as 1656, and in addition nitrate of soda at the rate of 160 pounds. Quite a good growth and of fair color. Bottom growth quite heavy. No. 1666 was from a plot which had dissolved bone-black and muriate of potash at the same rate as 1656, and in addition nitrate of soda at the rate of 480 pounds per acre. There was a heavy crop of dark green color. Bottom growth very thick.

1652, 1657, 1662, 1667, *Brome grass (Bromus inermis)*.—Grown in the Station grass garden in 1896. Samples were taken June 30, in the early seed stage. Stems quite woody. No. 1652 was from a plot to which no fertilizer had been applied. The growth was thin and stemmy. No. 1657 was from a plot which had dissolved bone-black at the rate of 320 pounds per acre, and muriate of potash at the rate of 160 pounds. A thin growth, somewhat heavier than on 1652. No. 1662 was from a plot which had dissolved bone-black and muriate of potash at the same rate as 1657, and in addition nitrate of soda at the rate of 160 pounds per acre. A medium heavy growth of good color; not much leaf growth. No. 1667 was from a plot which had dissolved bone-black and muriate of potash at the same rate as 1657, and in addition nitrate of soda at the rate of 480 pounds. Medium heavy growth of dark green color. The growth on the whole was rather stemmy; not equal to timothy, fescue, or orchard grass on corresponding plots.

1653, 1658, 1663, 1668, *Red-top (Agrostis vulgaris)*.—Grown in the Station grass garden in 1896. The samples were taken July 14, in the early seed stage. Stems quite succulent, but flower heads rather brown. No. 1653 was from a plot which had no fertilizer. There was a fine thick growth, quite small, not as pale colored as other varieties. No. 1658 was from a plot which had dissolved bone-black at the rate of 320 pounds, and muriate of potash at the rate of 160 pounds, per acre. A little heavier growth than on 1653. No. 1663 was

from a plot which had dissolved bone-black and muriate of potash at the same rate as 1658, and in addition nitrate of soda at the rate of 160 pounds per acre. A thick, fine growth, medium heavy, and of good color. No. 1668 was from a plot which had dissolved bone-black and muriate of potash at the same rate as 1658, and in addition nitrate of soda at the rate of 480 pounds per acre. The growth was thick, dark green in color, and quite heavy. There was a slight admixture of timothy on all plots, which was rejected in taking samples.

1675, 1696, *Millet fodder*.—Barnyard millet, sampled August 8 and 12, 1896, in connection with sheep digestion experiment No. 38. The millet was from bloom to early seed stage, the stems being slightly woody.

1677, 1701, *Millet fodder* in about the same stage as Nos. 1675 and 1696. Sampled August 20 and 28, 1896, in connection with sheep feeding experiment No. 41.

1703, 1705, *Cow pea fodder*.—This sample was taken in connection with sheep digestion experiment No. 43. The cow peas were cut September 3 and 7, 1896, at which time they had attained a medium heavy growth, though not full grown. They were beginning to twine, and were quite succulent.

1718–1726, 1731, *Cow pea fodder*.—Grown by the Station in 1896 as part of a special nitrogen experiment. For description of the experiment see pages 101–106 of the Eighth Annual Report, and page 278 of this Report. The samples were taken September 18 and 21. Nos. 1718 and 1719 were from plots without fertilizers. Nos. 1720 and 1721 were from plots to which were applied dissolved bone-black at the rate of 320 pounds per acre, and muriate of potash at the rate of 160 pounds. Nos. 1722, 1723, and 1731 were grown on plots to which mixed minerals were applied, as in 1720 and 1721, and had in addition 160, 320, and 480 pounds of nitrate of soda per acre respectively. Nos. 1724, 1725, and 1726 were grown on plots to which mixed minerals were applied, as in 1720 and 1721, and had in addition 120, 240, and 360 pounds of sulphate of ammonia per acre respectively.

1669, 1670, *Oat fodder*.—The samples, which were taken July 10 and 15, 1896, were in connection with sheep digestion experiment No. 34. The oats were full grown with large and slightly woody stems. The seeds were about half grown.

1673, 1674, *Oat fodder*.—Sampled July 23 and 27, 1896, in connection with sheep digestion experiment No. 37. The oats were in the early milk stage, quite green and succulent.

1671, 1672, *Oat and pea fodder*.—Used in sheep digestion experiments Nos. 35 and 36 respectively. The samples were taken July 15 and 23, 1896. The oats were full size, stems quite woody, and seeds about half grown. Peas with but few blossoms, and seeds full grown in many pods. The peas were quite badly lodged, and many stems were blackened. The proportion of oats and peas was about half-and-half.

1704, 1728, *Rowen*.—Fine grasses and clover in about the proportion of four to one. Sampled September 17 and 21, 1896, in connection with sheep digestion experiment No. 44.

1702, 1727, 1729, 1730, *Sweet corn fodder.*—"Branching Sweet" variety, in early roasting stage. Stalks quite succulent and proportion of ears large. Nos. 1702 and 1727 were taken September 3 and 7, 1896, in connection with sheep digestion experiment No. 42. Nos. 1729 and 1730 were taken September 17 and 21, 1896, in connection with sheep digestion experiment No. 45.

1697, 1698, *Soy bean fodder.*—Sampled August 8 and 12, 1896, in connection with sheep digestion experiment No. 39. The soy beans were generally in bloom and growing rapidly, but not full grown.

1676, 1699, 1700, *Soy bean fodder.*—Sampled August 20, 24, and 28, 1896, in connection with sheep digestion experiment No. 40. Crop from second sowing, about two-thirds grown, from bloom to early seed stage, and quite succulent.

SILAGE AND CORN STOVER.

1596, *Corn silage.*

1600, *Corn silage.*—Raised from Virginia grown seed, B. and W., white ensilage corn, by L. D. Lyman, of Middlefield. When cut it was from thirteen to fifteen feet tall, and was beginning to glaze.

1591, *Corn stover.*—Analyzed in connection with cow feeding experiments Nos. 35 and 37.

1618, *Corn stover.*—Analyzed in connection with cow feeding experiments Nos. 36 and 38.

1736–1745, *Stover of yellow flint corn.*—Grown by Station in 1896. (For further description see page 206.) Nos. 1736 and 1737 were from plots without fertilizers. Nos. 1738 and 1739 were from plots to which there were applied dissolved bone-black at the rate of 320 pounds per acre, and muriate of potash at the rate of 160 pounds. Nos. 1740, 1741, and 1742 were grown on plots to which mixed minerals were applied, as in 1738 and 1739, and had in addition 160, 320, and 480 pounds of nitrate of soda per acre respectively. Nos. 1743, 1744, and 1745 were grown on plots to which mixed minerals were applied, as in 1738 and 1739, and had in addition 120, 240, and 360 pounds of sulphate of ammonia per acre respectively.

1746–1755, *Stover of white flint corn.*—Grown by the Station in 1896. (For further description see page 206.) Nos. 1746 and 1747 were from plots without fertilizers. Nos. 1748 and 1749 were from plots to which there were applied dissolved bone-black at the rate of 320 pounds per acre, and muriate of potash at the rate of 160 pounds per acre. Nos. 1750, 1751, and 1752 were grown on plots to which mixed minerals were applied, as in 1748 and 1749, and had in addition 160, 320, and 480 pounds of nitrate of soda per acre respectively. Nos. 1753, 1754, and 1755 were grown on plots to which mixed minerals were applied, as in 1748 and 1749, and had in addition 120, 240, and 360 pounds of sulphate of ammonia per acre respectively.

CURED HAYS AND ROWEN.

1593, *Clover hay.*—Used in cow feeding experiment No. 37.

1622, 1623, *Clover rowen.*—Field cured and barn cured respectively. Used in sheep digestion experiments Nos. 28 and 29.

1617, *Hay.*—Second quality from fine meadow grasses. Used in cow feeding experiments Nos. 36 and 38.

1621, *Millet and Hungarian hay.*—Half-and-half. Used in cow feeding experiments Nos. 36 and 38.

1592, *Oat hay.*—Used in cow feeding experiment No. 35.

1613, *Oat hay.*

1625, *Oat hay.*—Cut when about two-thirds grown. Used in sheep digestion experiment No. 31.

1599, *Swamp hay.*

1624, 1641, 1642, *Fine rowen hay.*—From mixed grasses. Grown by the Station, and used in sheep digestion experiments Nos. 30, 32, and 33 respectively.

SPECIAL NITROGEN EXPERIMENT.

In the year 1895 the Station began a series of field experiments on the effects of nitrogenous fertilizers on the yield and composition of corn, cow pea fodder, and soy bean seed. Samples of the seeds, the fodder, or the stover were taken from the various plots at the time of harvest, and have, in most cases, been analyzed. Samples 1718–1726, 1731 of cow pea fodder, and samples 1736–1745 and 1746–1755 of corn stovers, and the two lots of flint corn, 1756–1765 and 1766–1775, described below, represent samples taken in connection with this experiment. For a full description of the experiment, see pages 101–106 of the Eighth Annual Report, and page 205 of this Report.

SEEDS.

1756–1765, *Yellow flint corn.*—Grown by the Station in 1896. Nos. 1756 and 1757 were from plots without fertilizers. Nos. 1758 and 1759 were from plots to which were applied dissolved bone-black at the rate of 320 pounds per acre, and muriate of potash at the rate of 160 pounds per acre. Nos. 1760, 1761, and 1762 were grown on plots to which mixed minerals were applied, as in 1758 and 1759, and had in addition 160, 320, and 480 pounds of nitrate of soda per acre respectively. Nos. 1763, 1764, and 1765 were grown on plots to which mixed minerals were applied, as in 1758 and 1759, and had in addition 120, 240, and 360 pounds of sulphate of ammonia per acre respectively.

1766–1775, *White flint corn.*—Grown by the Station in 1896. Nos. 1766 and 1767 were from plots without fertilizers. Nos. 1768 and 1769 were from plots to which there were applied dissolved bone-black at the rate of 320 pounds per acre, and muriate of potash at the rate of 160 pounds per acre. Nos. 1770, 1771, and 1772 were grown on plots to which mixed minerals were applied, as in 1768 and 1769, and had in addition 160, 320, and 480 pounds of nitrate of

soda per acre respectively. Nos. 1773, 1774, and 1775 were grown on plots to which mixed minerals were applied, as in 1768 and 1769, and had in addition 120, 240, and 360 pounds of sulphate of ammonia per acre respectively.

1706–1717, *Oats.*—Grown by the Station in 1896 in rotation soil test. (See page 213 of this Report.) The plots have received the same kinds and amounts of fertilizers for the past eight years. Nos. 1715, 1716, and 1717 were from plots without fertilizers. No. 1706 was from a plot to which 160 pounds per acre of nitrate of soda had been applied. No. 1707 was from a plot to which 320 pounds per acre of dissolved bone-black had been applied. No. 1708 grew on a plot which had received at the rate of 160 pounds of muriate of potash per acre. No. 1709 was from a plot receiving both nitrate of soda, as 1706, and dissolved bone-black, as 1707. The plot on which 1710 was grown received both nitrate of soda, as 1706, and muriate of potash, as 1708. No. 1711 was grown with dissolved bone-black, as 1707, and muriate of potash, as 1708, while 1712 received all three forms of fertilizer, as 1706, 1707, 1708. No. 1714 was from a plot receiving stable manure, and 1713 from a plot receiving stable manure and dissolved bone-black, 160 pounds per acre.

MILLING AND BY-PRODUCTS.

1588, *Corn meal.*—Made from Western grown corn. Used in cow feeding experiment No. 35.

1598, *Corn meal.*

1620, *Corn meal.*—With a small amount of cob. Used in feeding experiments with cows, Nos. 36 and 38.

1615, *Buffalo gluten feed.*—Used in feeding experiments, Nos. 36 and 38, with cows.

1594, *Chicago gluten meal.*—Used in feeding experiment, No. 37, with cows.

1614, *Chicago gluten meal.*

1616, *Linseed oil meal.*—Used in cow feeding experiments, Nos. 36 and 38.

1590, 1595, *Wheat bran.*—Used in feeding experiments with cows, Nos. 35 and 37.

1597, *Wheat bran.*

1603, 1604, *Wheat bran.*—From winter wheat and spring wheat respectively.

1619, *Wheat bran.*—Used in feeding experiments, Nos. 36 and 38, with cows.

1643, *Wheat bran (coarse).*—Used in sheep digestion experiment No. 32.

1589, *Wheat middlings.*—Used in feeding experiments, Nos. 35 and 37, with cows.

1601, 1602, *Wheat middlings.*—From winter wheat and spring wheat respectively.

1644, *Wheat middlings (No. 2).*—Used in sheep digestion experiment No. 33.

TABLE 73.

Composition of fodders and feeding stuffs analyzed 1895–96. Calculated to water content at time of taking sample.

Lab. No.	FEEDING STUFFS.	Water.	Protein.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Fuel Val. per Lb.
	Green Fodders.	%	%	%	%	%	%	Cal.
1649	Timothy, - - -	62.40	3.20	1.68	19.33	10.99	2.40	695
1654	Timothy, - - -	61.40	2.47	1.28	19.95	12.62	2.28	705
1659	Timothy, - - -	63.62	2.48	1.08	18.49	12.26	2.07	665
1664	Timothy, - - -	63.69	2.86	1.14	18.85	11.66	1.80	665
	Average (4), - -	**62.78**	**2.75**	**1.30**	**19.15**	**11.88**	**2.14**	**685**
	Avg. all analyses (16),	**68.60**	**2.60**	**1.00**	**15.30**	**10.50**	**2.00**	**570**
1650	Orchard grass, - -	66.02	3.43	1.78	14.83	10.70	3.24	615
1655	Orchard grass, - -	66.63	3.18	1.68	14.24	10.81	3.46	595
1660	Orchard grass, - -	71.49	2.87	1.32	11.36	10.10	2.86	505
1665	Orchard grass, - -	72.87	3.21	1.46	11.54	8.59	2.33	495
	Average (4), - -	**69.26**	**3.17**	**1.56**	**12.99**	**10.05**	**2.97**	**560**
	Avg. all analyses (16),	**68.60**	**3.00**	**1.30**	**13.60**	**10.70**	**2.80**	**565**
1651	Meadow fescue, -	65.27	3.25	1.69	16.87	10.00	2.92	630
1656	Meadow fescue, -	66.28	3.12	1.30	16.89	9.77	2.64	610
1661	Meadow fescue, -	69.22	3.10	1.20	15.17	8.68	2.63	550
1666	Meadow fescue, -	72.57	3.45	1.35	12.12	8.31	2.20	500
	Average (4), - -	**68.33**	**3.23**	**1.39**	**15.26**	**9.19**	**2.60**	**575**
	Avg. all analyses (14),	**71.60**	**2.50**	**1.00**	**13.00**	**9.80**	**2.10**	**515**
1652	Bromus inermis, -	63.63	2.92	1.26	18.94	10.49	2.76	655
1657	Bromus inermis, -	64.35	2.88	1.21	18.43	9.92	3.21	630
1662	Bromus inermis, -	66.07	3.19	1.19	17.24	9.68	2.63	610
1667	Bromus inermis, -	70.09	4.00	1.27	13.37	9.07	2.20	545
	Avg. all analyses (4),	**66.04**	**3.25**	**1.23**	**16.99**	**9.79**	**2.70**	**610**
1653	Red-top, - - -	56.54	2.91	1.41	23.12	12.86	3.16	780
1658	Red-top, - - -	58.93	2.72	1.35	21.90	12.46	2.64	745
1663	Red-top, - - -	62.74	3.06	1.39	19.53	10.72	2.56	680
1668	Red-top, - - -	61.53	3.80	1.34	20.05	10.92	2.36	705
	Avg. all analyses (4),	**59.94**	**3.12**	**1.37**	**21.15**	**11.74**	**2.68**	**730**
1675	Millet fodder, - -	75.49	2.03	.91	12.07	7.26	2.24	435
1696	Millet fodder, - -	75.59	1.73	.61	12.21	7.78	2.08	430
1677	Millet fodder, - -	66.51	2.12	1.36	17.67	10.08	2.26	615
1701	Millet fodder, - -	71.09	1.22	.72	15.73	9.22	2.02	515
	Avg. all analyses (4),	**72.17**	**1.77**	**.90**	**14.42**	**8.59**	**2.15**	**500**
1703	Cow pea fodder, -	84.03	2.81	.57	6.92	3.77	1.90	275
1705	Cow pea fodder, -	84.74	2.97	.57	6.31	3.57	1.84	265
1718	Cow pea fodder, -	81.72	3.08	.53	7.86	4.61	2.20	310
1719	Cow pea fodder, -	79.08	4.19	.82	9.40	3.97	2.54	360
1720	Cow pea fodder, -	84.89	2.97	.54	6.25	3.41	1.94	260
1721	Cow pea fodder, -	82.57	3.18	.50	7.81	3.92	2.02	300
1722	Cow pea fodder, -	82.33	2.97	.53	8.15	4.06	1.96	305
1723	Cow pea fodder, -	82.90	3.23	.49	7.43	3.88	2.07	290
1724	Cow pea fodder, -	83.46	3.15	.51	6.89	4.03	1.96	285
1725	Cow pea fodder, -	82.76	2.86	.47	7.95	4.09	1.87	300
1726	Cow pea fodder, -	85.27	3.15	.39	5.66	3.57	1.96	245
1731	Cow pea fodder, -	83.44	3.23	.62	7.41	3.38	1.92	285
	Average (12), - -	**83.10**	**3.15**	**.54**	**7.34**	**3.85**	**2.02**	**290**
	Avg. all analyses (49),	**83.00**	**3.00**	**.60**	**7.70**	**3.70**	**2.00**	**295**

TABLE 73.—(*Continued.*)

Lab. No.	FEEDING STUFFS.	Water.	Protein.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Fuel Val. per Lb.
	Green Fodders.	%	%	%	%	%	%	Cal.
1669	Oat fodder,	67.16	3.47	1.46	15.70	9.71	2.50	600
1670	Oat fodder,	66.95	3.05	1.46	16.35	9.88	2.31	605
1673	Oat fodder,	74.04	2.60	1.09	11.65	8.45	2.17	470
1674	Oat fodder,	73.03	2.84	1.15	12.72	8.20	2.06	490
	Average (4),	**70.29**	**2.99**	**1.29**	**14.11**	**9.06**	**2.26**	**540**
	Avg. all analyses (6),	**73.60**	**2.90**	**1.20**	**12.30**	**7.80**	**2.20**	**480**
1671	Oat and pea fodder,	68.83	4.00	1.57	15.12	8.28	2.20	575
1672	Oat and pea fodder,	71.41	4.68	1.30	10.63	9.94	2.04	525
	Average (2),	**70.12**	**4.34**	**1.43**	**12.88**	**9.11**	**2.12**	**550**
	Avg. all analyses (7),	**79.90**	**3.60**	**1.00**	**8.30**	**5.50**	**1.70**	**365**
1704	Rowen,	75.68	3.51	1.39	11.32	6.16	1.94	450
1728	Rowen,	70.24	4.02	1.57	13.61	8.05	2.51	545
	Average (2),	**72.96**	**5.76**	**1.48**	**12.47**	**7.11**	**2.22**	**500**
	Avg. all analyses (10),	**77.70**	**3.70**	**1.00**	**9.60**	**6.00**	**2.00**	**400**
1702	Sweet corn fodder,	82.76	1.69	.49	10.41	3.56	1.09	310
1727	Sweet corn fodder,	79.43	1.94	.53	12.23	4.64	1.23	370
1729	Sweet corn fodder,	82.64	1.84	.47	9.87	4.03	1.15	315
1730	Sweet corn fodder,	81.02	1.84	.62	10.92	4.45	1.15	345
	Average (4),	**81.46**	**1.83**	**.53**	**10.86**	**4.17**	**1.15**	**335**
	Avg. all analyses (6),	**80.80**	**1.80**	**.50**	**11.40**	**4.30**	**1.20**	**345**
1697	Soy bean fodder,	79.51	3.15	.66	7.97	6.39	2.32	355
1698	Soy bean fodder,	77.12	3.27	.87	8.70	7.61	2.43	400
1676	Soy bean fodder,	75.96	3.80	1.22	10.58	6.03	2.41	430
1699	Soy bean fodder,	77.42	3.56	.93	8.64	7.16	2.29	400
1700	Soy bean fodder,	75.78	2.69	.92	11.77	6.50	2.34	430
	Average (5),	**77.16**	**3.29**	**.92**	**9.53**	**6.74**	**2.36**	**405**
	Avg. all analyses (13),	**76.50**	**3.60**	**1.00**	**10.10**	**6.50**	**2.30**	**420**
	Ensilage.							
1596	Ensilage,	53.36	3.14	1.46	30.59	9.38	2.07	865
1600	Corn ensilage,	75.98	1.75	.67	13.97	6.34	1.29	440
	Avg. all analyses (14),	**75.40**	**1.90**	**.90**	**14.00**	**6.40**	**1.40**	**455**
	Cured Fodders.							
1591	Corn stover,	11.37	6.47	2.06	43.84	29.57	6.69	1575
1618	Corn stover,	27.61	3.19	1.13	36.08	26.33	5.66	1265
1736	Corn stover,	43.69	4.36	.70	29.34	17.61	4.30	985
1737	Corn stover	46.15	3.60	1.07	24.90	20.32	3.96	955
1738	Corn stover,	43.78	3.01	1.18	27.62	20.32	4.09	1000
1739	Corn stover,	43.63	2.85	1.28	28.25	19.87	4.12	1005
1740	Corn stover,	42.29	3.04	1.15	26.68	22.90	3.94	1030
1741	Corn stover,	46.39	3.71	.99	25.09	19.88	3.94	950
1742	Corn stover,	40.19	4.21	1.14	27.99	21.95	4.52	1055
1743	Corn stover,	42.36	3.14	1.31	28.04	20.89	4.26	1025
1744	Corn stover,	53.66	2.89	.86	22.77	16.46	3.36	820
1745	Corn stover,	48.76	4.38	.99	24.93	17.05	3.89	905
1746	Corn stover,	16.51	6.12	1.49	40.60	28.88	6.40	1470
1747	Corn stover,	17.35	5.27	1.37	41.22	28.84	5.95	1460
1748	Corn stover,	22.93	3.68	1.63	39.49	25.76	6.51	1350
1749	Corn stover,	25.12	3.38	1.31	37.04	26.98	6.17	1310
1750	Corn stover,	22.37	3.79	1.69	40.14	25.85	6.16	1370

TABLE 73.—*(Continued.)*

Lab. No.	FEEDING STUFFS.	Water.	Protein.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Fuel Val. per l.b.
	Cured Fodders.	%	%	%	%	%	%	Cal.
1751	Corn stover, - -	25.50	4.45	1.48	36.40	26.75	5.42	1320
1752	Corn stover, - -	22.55	6.43	1.51	39.38	24.46	5.67	1390
1753	Corn stover, - -	29.36	3.32	1.55	35.81	23.82	6.14	1235
1755	Corn stover, - -	31.45	3.98	1.43	34.17	23.14	5.83	1200
1754	Corn stover, - -	30.67	4.84	1.25	32.11	25.90	5.23	1220
	Average (22), - -	**33.35**	**4.10**	**1.30**	**32.81**	**23.34**	**5.10**	**1175**
	Avg. all analyses (174),	**41.60**	**3.60**	**1.20**	**29.80**	**20.00**	**3.80**	**1045**
	Cured Hays and Rowen.							
1593	Clover hay, - -	6.44	14.63	2.24	38.70	31.86	6.13	1675
1622	Clover rowen, - -	15.13	15.64	3.61	37.36	21.02	7.24	1530
1623	Clover rowen, - -	14.56	17.39	3.82	37.20	19.68	7.35	1545
	Average (2), - -	**14.84**	**16.52**	**3.72**	**37.28**	**20.25**	**7.29**	**1540**
	Avg. all analyses (6),	**11.20**	**15.50**	**3.50**	**39.10**	**23.90**	**6.80**	**1610**
1617	Hay, 2d quality, -	5.89	11.75	2.41	44.07	31.15	4.73	1720
	Avg. all analyses (3),	**10.00**	**9.40**	**2.80**	**42.80**	**28.50**	**5.50**	**1620**
1621	Hay, millet and Hungarian), - - -	6.65	6.47	2.20	44.44	35.02	5.22	1690
1592	Hay, oat, - - -	8.16	7.85	3.59	44.87	29.59	5.94	1685
1613	Hay, oat, - - -	5.55	8.13	2.71	45.88	32.38	5.33	1720
1623	Hay, oat, - - -	12.25	9.79	4.14	42.48	25.79	5.55	1625
	Average (3), - -	**8.65**	**8.59**	**3.48**	**44.41**	**29.26**	**5.61**	**1675**
	Avg. all analyses (12),	**11.60**	**8.40**	**3.30**	**43.40**	**27.90**	**5.40**	**1620**
1599	Hay, swamp, - -	6.30	9.06	3.09	48.91	26.17	6.47	1695
	Avg. all analyses (3),	**8.10**	**9.60**	**3.30**	**46.00**	**26.80**	**6.20**	**1670**
1624	Hay, fine rowen, -	10.51	14.40	4.43	42.91	21.08	6.67	1645
1641	Hay, fine rowen, -	13.24	13.54	4.93	40.14	20.64	7.51	1590
1642	Hay, fine rowen, -	8.84	13.06	4.81	44.25	22.02	7.02	1680
	Average (3), - -	**10.86**	**13.67**	**4.72**	**42.43**	**21.25**	**7.07**	**1640**
	Avg. all analyses (41),*	**13.00**	**9.20**	**3.20**	**42.30**	**26.80**	**5.50**	**1590**
	Seeds.							
1756	Corn, - - -	28.40	7.09	4.16	57.71	1.49	1.15	1410
1757	Corn, - - -	26.92	7.47	4.27	58.61	1.40	1.31	1435
1758	Corn, - - -	27.00	6.80	4.53	58.88	1.48	1.33	1440
1759	Corn, - - -	26.81	6.86	4.30	59.29	1.49	1.25	1440
1760	Corn, - - -	29.54	6.58	3.95	57.89	.96	1.08	1385
1761	Corn. - - -	29.14	7.62	4.14	56.92	.98	1.20	1390
1762	Corn, - - -	28.26	8.38	4.50	56.54	1.05	1.27	1420
1763	Corn, - - -	25.26	7.63	5.07	59.47	1.19	1.38	1485
1764	Corn, - - -	29.09	6.99	4.95	56.48	1.12	1.37	1410
1765	Corn, - - -	22.68	8.60	4.76	61.56	1.02	1.38	1525
1766	Corn, - - -	16.10	9.34	4.58	67.24	1.24	1.50	1640
1767	Corn, - - -	24.99	8.41	3.90	60.21	1.21	1.28	1465
1768	Corn, - - -	15.47	8.10	4.53	69.31	1.12	1.47	1650
1769	Corn, - - -	22.54	7.61	4.13	63.54	.94	1.24	1515
1770	Corn, - - -	20.81	8.06	4.67	63.80	1.07	1.59	1555
1771	Corn, - - -	21.09	8.99	5.31	61.74	1.37	1.50	1565
1772	Corn, - - -	21.33	9.80	4.46	61.73	1.26	1.42	1545
1773	Corn, - - -	22.02	8.51	4.34	62.86	.98	1.29	1525
1774	Corn, - - -	21.15	8.64	5.16	62.25	1.21	1.59	1560

TABLE 73.—*(Concluded.)*

Lab. No.	FEEDING STUFFS.	Water.	Protein.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Fuel Val. per Lb.
	Seeds.	%	%	%	%	%	%	Cal.
1775	Corn, - - - -	22.03	9.38	4.96	61.09	1.01	1.53	1540
	Average (20), - -	**24.03**	**8.04**	**4.53**	**60.86**	**1.18**	**1.36**	**1495**
	Avg. all analyses (173),	**18.90**	**9.00**	**4.70**	**64.70**	**1.30**	**1.40**	**1595**
1706	Oats, - - - -	9.07	13.50	5.96	61.94	6.58	2.95	1775
1707	Oats, - - - -	8.17	11.31	5.93	63.33	7.96	3.30	1785
1708	Oats, - - - -	9.26	11.50	5.70	62.20	8.27	3.05	1765
1709	Oats, - - - -	8.25	11.69	5.83	64.74	6.72	2.77	1790
1710	Oats, - - - -	8.41	12.94	5.97	62.98	6.97	2.73	1790
1711	Oats, - - - -	10.05	10.81	5.80	63.89	6.73	2.72	1760
1712	Oats, - - - -	7.33	11.02	5.60	64.21	9.06	2.78	1805
1713	Oats, - - - -	7.81	11.13	5.50	63.64	9.02	2.90	1790
1714	Oats, - - - -	8.59	11.69	5.64	64.74	6.64	2.70	1780
1715	Oats, - - - -	10.94	11.73	5.65	61.28	7.58	2.82	1735
1716	Oats, - - - -	9.98	11.62	5.63	61.19	8.46	3.12	1750
1717	Oats, - - - -	8.58	12.00	5.40	62.08	8.93	3.01	1770
	Average (12), - -	**8.87**	**11.75**	**5.72**	**63.02**	**7.74**	**2.90**	**1775**
	Avg. all analyses (50),	**12.80**	**12.70**	**5.20**	**58.10**	**8.50**	**2.70**	**1695**
	Milling and By-Products.							
1588	Corn meal, - -	11.98	9.19	5.46	70.00	1.79	1.58	1735
1598	Corn meal, - -	11.48	10.69	5.37	69.16	1.84	1.46	1750
1620	Corn meal, - -	10.78	10.15	4.55	70.75	2.20	1.57	1740
	Average (3), - -	**11.41**	**10.01**	**5.13**	**69.97**	**1.94**	**1.54**	**1740**
	Avg. all analyses (23),	**12.90**	**9.60**	**4.50**	**69.90**	**1.60**	**1.50**	**1700**
1615	Buffalo gluten feed, -	8.23	26.75	5.25	52.54	5.53	1.70	1800
	Avg. all analyses (5),	**8.60**	**22.60**	**12.00**	**49.10**	**6.10**	**1.10**	**1965**
1594	Chicago gluten meal, -	9.56	33.02	7.74	45.03	3.93	.72	1850
1614	Chicago gluten meal, -	8.10	43.13	5.27	40.37	2.21	.92	1820
	Average (2), - -	**8.83**	**38.08**	**6.50**	**42.70**	**3.07**	**.82**	**1835**
	Avg. all analyses (7),	**8.70**	**35.40**	**6.30**	**45.90**	**2.70**	**1.00**	**1830**
1616	Linseed oil meal, -	8.00	38.44	6.74	32.93	8.63	5.26	1770
	Avg. all analyses (10),	**10.30**	**33.88**	**5.30**	**37.40**	**7.60**	**5.60**	**1690**
1590	Wheat bran, - -	8.73	18.00	4.97	54.92	7.70	5.68	1710
1595	Wheat bran, - -	8.45	17.44	4.55	55.02	9.13	5.41	1710
1597	Wheat bran, - -	9.75	17.62	5.56	52.97	8.95	5.15	1715
1603	Wheat bran, winter, -	7.94	17.75	4.32	54.90	8.78	6.31	1695
1604	Wheat bran, spring, -	7.77	17.31	5.58	54.54	9.56	5.24	1750
1619	Wheat bran, - -	6.77	18.06	4.67	57.39	7.97	5.14	1750
1643	Wheat bran, coarse, -	7.05	15.25	5.44	55.08	11.12	6.06	1745
	Average (7), - -	**8.07**	**17.35**	**5.01**	**54.97**	**9.03**	**5.57**	**1725**
	Avg. all analyses (38),	**9.40**	**17.20**	**5.10**	**53.70**	**9.10**	**5.50**	**1705**
1689	Wheat middlings, -	9.93	17.00	3.96	63.89	2.78	2.44	1725
1601	Wheat middl'gs, winter,	9.27	18.13	3.83	60.20	5.30	3.27	1715
1602	Wheat middl'gs, spring,	10.47	20.13	5.57	52.73	6.65	4.45	1715
1644	Wheat middlings, -	8.41	18.69	5.79	52.54	9.60	4.97	1745
	Average (4), - -	**9.52**	**18.49**	**4.79**	**57.34**	**6.08**	**3.78**	**1725**
	Avg. all analyses (16),	**10.30**	**18.30**	**5.10**	**56.30**	**6.00**	**4.00**	**1715**

* These include hay from mixed grasses as well as rowen from mixed grasses.

TABLE 74.

Composition of water-free substance of fodders and feeding stuffs analyzed 1895–96.

Lab. No.	FEEDING STUFFS.	Protein.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Fuel Val. per Lb.
	Green Fodders.	%	%	%	%	%	Cal.
1649	Timothy, - - - - -	8.51	4.46	51.42	29.22	6.39	1850
1654	Timothy, - - - - -	6.41	3.32	51.68	32.68	5.91	1830
1659	Timothy, - - - - -	6.82	2.95	50.82	33.71	5.70	1825
1664	Timothy, - - - - -	7.89	3.13	51.91	32.12	4.95	1840
	Average (4), - - - -	**7.41**	**3.46**	**51.46**	**31.93**	**5.74**	**1835**
	Average all analyses (16),	**8.52**	**3.22**	**48.39**	**33.61**	**6.26**	**1820**
1650	Orchard grass, - - - -	10.09	5.25	43.65	31.47	9.54	1810
1655	Orchard grass, - - - -	9.53	5.03	42.67	32.40	10.37	1785
1660	Orchard grass, - - - -	10.07	4.62	39.85	35.43	10.03	1780
1665	Orchard grass, - - - -	11.83	5.38	42.55	31.67	8.57	1830
	Average (4), - - - -	**10.38**	**5.07**	**42.18**	**32.74**	**9.63**	**1800**
	Average all analyses (16),	**9.74**	**4.25**	**43.23**	**33.92**	**8.86**	**1800**
1651	Meadow fescue, - - - -	9.36	4.85	48.59	28.79	8.41	1820
1656	Meadow fescue, - - - -	9.24	3.86	50.10	28.97	7.83	1810
1661	Meadow fescue, - - - -	10.07	3.90	49.29	28.20	8.54	1810
1666	Meadow fescue, - - - -	12.59	4.94	44.17	30.29	8.01	1825
	Average (4), - - - -	**10.31**	**4.39**	**48.04**	**29.06**	**8.20**	**1815**
	Average all analyses (14),	**9.02**	**3.30**	**45.31**	**34.69**	**7.68**	**1796**
1652	Bromus inermis, - - - -	8.02	3.48	52.06	28.84	7.60	1800
1657	Bromus inermis, - - - -	8.09	3.38	51.70	27.83	9.00	1775
1662	Bromus inermis, - - - -	9.39	3.51	50.82	28.52	7.76	1800
1667	Bromus inermis, - - - -	13.38	4.25	44.71	30.33	7.33	1825
	Average all analyses (4), -	**9.72**	**3.66**	**49.82**	**28.88**	**7.92**	**1800**
1653	Red-top, - - - - -	6.70	3.23	53.19	29.60	7.28	1800
1658	Red-top, - - - - -	6.62	3.30	53.32	30.34	6.42	1820
1663	Red-top, - - - - -	8.20	3.74	52.42	28.76	6.88	1820
1668	Red-top, - - - - -	9.86	3.50	52.11	28.39	6.14	1830
	Average all analyses (4), -	**7.85**	**3.44**	**52.76**	**29.27**	**6.68**	**1815**
1675	Millet fodder, - - - -	8.27	3.73	49.26	29.63	9.11	1780
1696	Millet fodder, - - - -	7.09	2.51	50.05	31.87	8.48	1760
1677	Millet fodder, - - - -	6.34	4.04	52.76	30.12	6.74	1830
1701	Millet fodder, - - - -	4.22	2.48	54.41	31.91	6.98	1790
	Average all analyses (4), -	**6.48**	**3.19**	**51.62**	**30.88**	**7.83**	**1790**
1703	Cow pea fodder, - - -	17.58	3.54	43.34	23.61	11.93	1720
1705	Cow pea fodder, - - -	19.44	3.71	41.36	23.39	12.10	1725
1718	Cow pea fodder, - - -	16.82	2.92	42.99	25.23	12.04	1705
1719	Cow pea fodder, - - -	20.03	3.91	44.95	18.96	12.15	1725
1720	Cow pea fodder, - - -	19.66	3.59	41.40	22.55	12.80	1710
1721	Cow pea fodder, - - -	18.23	2.87	44.84	22.48	11.58	1710
1722	Cow pea fodder, - - -	16.81	2.98	46.15	22.97	11.09	1725
1723	Cow pea fodder, - - -	18.90	2.88	43.44	22.67	12.11	1705
1724	Cow pea fodder, - - -	19.02	3.07	41.67	24.39	11.85	1715
1725	Cow pea fodder, - - -	16.61	2.71	46.10	23.70	10.88	1720
1726	Cow pea fodder, - - -	21.39	2.63	38.43	24.25	13.30	1670
1731	Cow pea fodder, - - -	19.49	3.76	44.72	20.41	11.62	1730
	Average (12), - - -	**18.67**	**3.22**	**43.28**	**22.88**	**11.95**	**1715**
	Average all analyses (49),	**18.09**	**3.47**	**44.74**	**22.15**	**11.55**	**1730**

TABLE 74.—*(Continued.)*

Lab. No.	FEEDING STUFFS.	Protein.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Fuel Val. per Lb.
	Green Fodders.	%	%	%	%	%	Cal.
1669	Oat fodder,	10.56	4.46	47.80	29.57	7.61	1825
1670	Oat fodder,	9.24	4.43	49.45	29.90	6.98	1835
1673	Oat fodder,	10.00	4.20	44.88	32.57	8.35	1805
1674	Oat fodder,	10.52	4.27	47.17	30.42	7.62	1820
	Average (4),	**10.08**	**4.34**	**47.33**	**30.61**	**7.64**	**1820**
	Average all analyses (6),	**11.28**	**4.62**	**46.32**	**29.44**	**8.34**	**1810**
1671	Oat and pea fodder,	12.84	5.03	48.51	26.55	7.07	1845
1672	Oat and pea fodder,	16.38	4.55	37.16	34.78	7.13	1835
	Average (2),	**14.61**	**4.79**	**42.84**	**30.66**	**7.10**	**1840**
	Average all analyses (7),	**18.92**	**5.01**	**40.61**	**26.69**	**8.77**	**1810**
1704	Rowen,	14.45	5.71	46.55	25.34	7.95	1845
1728	Rowen,	13.50	5.29	45.71	27.05	8.45	1830
	Average (2),	**13.98**	**5.50**	**46.13**	**26.19**	**8.20**	**1840**
	Average all analyses (10),	**17.09**	**4.03**	**42.64**	**27.05**	**9.19**	**1785**
1702	Sweet corn fodder,	9.80	2.87	60.38	20.63	6.32	1810
1727	Sweet corn fodder,	9.41	2.57	59.48	22.58	5.96	1810
1729	Sweet corn fodder,	10.62	2.70	56.87	23.19	6.62	1800
1730	Sweet corn fodder,	9.68	3.24	57.58	23.44	6.06	1825
	Average (4),	**9.88**	**2.84**	**58.58**	**22.46**	**6.24**	**1810**
	Average all analyses (6),	**9.35**	**2.85**	**59.31**	**22.32**	**6.17**	**1815**
1697	Soy bean fodder,	15.37	3.25	38.88	31.18	11.32	1725
1698	Soy bean fodder,	14.28	3.81	38.03	33.28	10.60	1755
1676	Soy bean fodder,	15.80	5.05	44.04	25.06	10.05	1795
1699	Soy bean fodder,	15.77	4.10	38.30	31.72	10.11	1770
1700	Soy bean fodder,	11.13	3.79	48.62	26.82	9.64	1770
	Average (5),	**14.47**	**4.00**	**41.58**	**29.61**	**10.34**	**1765**
	Average all analyses (13),	**15.26**	**4.09**	**43.04**	**27.57**	**10.04**	**1770**
	Ensilage.						
1596	Ensilage,	6.73	3.13	65.59	20.10	4.45	1850
1600	Corn ensilage,	7.28	2.79	58.15	26.41	5.37	1830
	Average all analyses (14),	**7.88**	**3.53**	**55.31**	**27.45**	**5.83**	**1835**
	Cured Fodders.						
1591	Corn stover,	7.30	2.33	49.46	33.36	7.55	1775
1618	Corn stover,	4.40	1.56	49.84	36.38	7.82	1750
1736	Corn stover,	7.75	1.24	52.10	31.27	7.64	1745
1737	Corn stover,	6.70	1.98	46.23	37.72	7.37	1770
1738	Corn stover,	5.37	2.11	49.12	36.13	7.27	1775
1739	Corn stover,	5.07	2.27	50.11	35.24	7.31	1775
1740	Corn stover,	5.28	2.00	46.22	39.67	6.83	1780
1741	Corn stover,	6.91	1.85	46.80	37.08	7.36	1770
1742	Corn stover,	7.04	1.92	46.80	36.69	7.55	1765
1743	Corn stover,	5.45	2.27	48.66	36.24	7.38	1780
1744	Corn stover,	6.25	1.86	49.13	35.51	7.25	1770
1745	Corn stover,	8.54	1.94	48.65	33.27	7.60	1765
1746	Corn stover,	7.33	1.79	48.63	34.59	7.66	1760
1747	Corn stover,	6.37	1.66	49.87	34.90	7.20	1765
1748	Corn stover,	4.77	2.11	51.24	33.43	8.45	1750
1749	Corn stover,	4.52	1.75	49.46	36.03	8.24	1750
1750	Corn stover,	4.89	2.17	51.70	33.30	7.94	1765

TABLE 74.—*(Continued.)*

Lab. No.	FEEDING STUFFS.	Protein.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Fuel Val. per Lb.
	Cured Fodders.	%	%	%	%	%	Cal.
1751	Corn stover,	5.97	1.99	48.85	35.91	7.28	1770
1752	Corn stover,	8.30	1.95	50.84	31.59	7.32	1770
1753	Corn stover,	4.70	2.20	50.70	33.71	8.69	1750
1754	Corn stover,	5.81	2.08	49.85	33.75	8.51	1750
1755	Corn stover,	6.99	1.81	46.31	37.36	7.53	1765
	Average (22),	**6.17**	**1.95**	**49.12**	**35.15**	**7.61**	**1765**
	Average all analyses (174),	**6.40**	**1.98**	**51.04**	**34.19**	**6.29**	**1790**
	Cured Hays and Rowen.						
1593	Clover hay,	15.64	2.40	41.36	34.05	6.55	1795
	Average all analyses (6),	**17.55**	**3.92**	**43.98**	**26.92**	**7.63**	**1810**
1622	Clover rowen,	18.43	4.26	44.02	24.77	8.52	1800
1623	Clover rowen,	20.36	4.47	43.54	23.03	8.60	1865
	Average all analyses (6),	**19.39**	**4.37**	**43.78**	**23.90**	**8.56**	**1835**
1617	Hay, second quality,	12.48	2.56	46.83	33.10	5.03	1830
	Average all analyses (3),	**10.47**	**3.17**	**48.17**	**31.90**	**6.29**	**1810**
1621	Hay, millet and Hungarian,	6.93	2.35	47.61	37.51	5.60	1815
1592	Hay, oat,	8.55	3.91	48.85	32.22	6.47	1830
1613	Hay, oat,	8.61	2.87	48.58	34.28	5.66	1825
1625	Hay, oat,	11.16	4.72	48.42	29.38	6.32	1855
	Average (3),	**9.44**	**3.83**	**48.62**	**31.96**	**6.15**	**1835**
	Average all analyses (12),	**9.54**	**3.79**	**49.21**	**31.42**	**6.04**	**1840**
1599	Hay, swamp,	9.67	3.30	52.20	27.93	6.90	1810
	Average all analyses (3),	**10.45**	**3.65**	**50.00**	**29.19**	**6.71**	**1820**
1624	Hay, fine rowen,	16.09	4.94	47.95	23.56	7.46	1840
1641	Hay, fine rowen,	15.60	5.68	46.27	23.79	8.66	1835
1642	Hay, fine rowen,	14.33	5.28	48.54	24.15	7.70	1840
	Average (3),	**15.34**	**5.30**	**47.59**	**23.83**	**7.94**	**1840**
	Average all analyses (41),*	**10.72**	**3.59**	**48.62**	**30.69**	**6.38**	**1825**
	Seeds.						
1756	Corn,	9.90	5.81	80.60	2.08	1.61	1965
1757	Corn,	10.22	5.84	80.20	1.92	1.82	1960
1758	Corn,	9.31	6.21	80.66	2.03	1.79	1970
1759	Corn,	9.38	5.88	81.01	2.03	1.70	1970
1760	Corn,	9.34	5.60	82.16	1.36	1.54	1965
1761	Corn,	10.76	5.85	80.31	1.39	1.69	1970
1762	Corn,	11.68	6.28	78.81	1.46	1.77	1975
1763	Corn,	10.20	6.79	79.56	1.60	1.85	1985
1764	Corn,	9.87	6.98	79.64	1.58	1.93	1990
1765	Corn,	11.13	6.16	79.62	1.31	1.78	1975
1766	Corn,	11.14	5.46	80.14	1.47	1.79	1955
1767	Corn,	11.21	5.20	80.27	1.61	1.71	1950
1768	Corn,	9.58	5.35	82.00	1.33	1.74	1955
1769	Corn,	9.82	5.34	82.03	1.21	1.60	1955
1770	Corn,	10.17	5.89	80.58	1.35	2.01	1960
1771	Corn,	11.40	6.73	78.23	1.74	1.90	1985
1772	Corn,	12.46	5.67	78.46	1.60	1.81	1960

* These include hay from mixed grasses as well as rowen from mixed grasses.

TABLE 74.—*(Concluded.)*

Lab. No.	FEEDING STUFFS.	Protein.	Fat.	Nit.-free Ext.	Fiber.	Ash.	Fuel Val. per Lb.
	Seeds.	%	%	%	%	%	Cal.
1773	Corn, - - - - - -	10.91	5.56	80.62	1.26	1.65	1965
1774	Corn, - - - - - -	10.96	6.55	78.94	1.54	2.01	1975
1775	Corn, - - - - - -	12.04	6.36	78.34	1.30	1.96	1975
	Average (20), - - -	**10.57**	**5.97**	**80.11**	**1.57**	**1.78**	**1965**
	Average all analyses (173),	**11.08**	**5.75**	**79.78**	**1.65**	**1.74**	**1965**
1706	Oats, - - - - - -	14.85	6.55	68.13	7.23	3.24	1955
1707	Oats, - - - - - -	12.31	6.46	68.97	8.67	3.59	1945
1708	Oats, - - - - - -	12.67	6.27	68.58	9.12	3.36	1945
1709	Oats, - - - - - -	12.74	6.36	70.56	7.32	3.02	1950
1710	Oats, - - - - - -	14.12	6.52	68.77	7.61	2.98	1955
1711	Oats, - - - - - -	12.02	6.45	71.03	7.48	3.02	1955
1712	Oats, - - - - - -	11.89	6.04	69.29	9.78	3.00	1945
1713	Oats, - - - - - -	12.07	5.97	69.03	9.78	3.15	1940
1714	Oats, - - - - - -	12.79	6.17	70.83	7.26	2.95	1950
1715	Oats, - - - - - -	13.17	6.34	68.81	8.51	3.17	1950
1716	Oats, - - - - - -	12.90	6.26	67.97	9.40	3.47	1945
1717	Oats, - - - - - -	13.13	5.90	67.91	9.77	3.29	1940
	Average (12), - - -	**12.89**	**6.27**	**69.16**	**8.49**	**3.19**	**1950**
	Average all analyses (50),	**14.61**	**5.97**	**66.52**	**9.76**	**3.14**	**1945**
	Milling and By-Products.						
1588	Corn meal, - - - -	10.44	6.20	79.53	2.03	1.80	1970
1598	Corn meal, - - - -	12.08	6.07	78.12	2.08	1.65	1975
1620	Corn meal, - - - -	11.38	5.10	79.30	2.47	1.75	1950
	Average (3), - - -	**11.30**	**5.79**	**78.99**	**2.19**	**1.73**	**1965**
	Average all analyses (23),	**11.07**	**5.19**	**80.26**	**1.81**	**1.67**	**1950**
1615	Buffalo gluten feed, - -	29.15	5.72	57.25	6.03	1.85	1960
	Average all analyses (6), -	**24.71**	**13.13**	**54.31**	**6.63**	**1.22**	**2145**
1594	Chicago gluten meal, - -	36.51	8.55	49.79	4.35	.80	2045
1614	Chicago gluten meal, - -	46.93	5.74	43.93	2.40	1.00	1980
	Average (2), - - -	**41.72**	**7.15**	**46.86**	**3.37**	**.90**	**2015**
	Average all analyses (7), -	**38.83**	**6.91**	**50.25**	**2.98**	**1.03**	**2005**
1616	Linseed oil meal, - -	41.78	7.33	35.79	9.38	5.72	1925
	Average all analyses (10),	**37.69**	**5.86**	**41.76**	**8.46**	**6.24**	**1885**
1590	Wheat bran, - - -	19.72	5.45	60.17	8.44	6.22	1875
1595	Wheat bran, - - -	19.05	4.97	60.10	9.97	5.91	1870
1597	Wheat bran, - - -	19.52	6.16	58.70	9.91	5.71	1900
1603	Wheat bran, winter, - -	19.28	4.69	59.64	9.54	6.85	1845
1604	Wheat bran, spring, - -	18.77	6.05	59.14	10.36	5.68	1900
1619	Wheat bran, - - -	19.37	5.01	61.56	8.55	5.51	1875
1643	Wheat bran, coarse, - -	16.41	5.85	59.26	11.96	6.52	1875
	Average (7), - - -	**18.87**	**5.45**	**59.80**	**9.82**	**6.06**	**1875**
	Average all analyses (38),	**19.01**	**5.60**	**59.25**	**10.02**	**6.12**	**1880**
1589	Wheat middlings, - -	18.87	4.40	70.93	3.09	2.71	1915
1601	Wheat middlings, winter, -	19.99	4.22	66.35	5.84	3.60	1890
1602	Wheat middlings, spring, -	22.48	6.22	58.90	7.43	4.97	1915
1644	Wheat middlings, - -	20.41	6.32	57.37	10.48	5.42	1905
	Average (4), - - -	**20.44**	**5.29**	**63.39**	**6.71**	**4.17**	**1905**
	Average all analyses (16),	**20.45**	**5.66**	**62.85**	**6.61**	**4.43**	**1910**

METEOROLOGICAL OBSERVATIONS.

BY C. S. PHELPS.

The meteorological observations made at the Station during 1896 have been similar to those of past years. The Station equipment consists of the ordinary instruments for observing temperatures, pressures of the air, humidity, rainfall and snowfall, uniform with those used by voluntary observers for the United States Weather Service. In addition to the records made at Storrs, the rainfall for the growing season has been recorded by quite a number of farmers in coöperation with the Station.

The total precipitation for the year (40.6 inches), as measured at Storrs, was considerably below the average yearly rainfall for this State. The average for Connecticut from observers having records covering more than five years prior to 1896, as given by the New England Meteorological Society, is 48.5 inches. The average at Storrs for the past eight years is 44.2 inches, and the average from fifteen observers of the New England Meteorological Society in the State having records covering the five years prior to 1896 is 44.7 inches. The rainfall was unusually large during the months of February and March, while April, May, and June gave an unusually small amount of rainfall. The rainfall throughout the remainder of the growing season was sufficient to keep up a fair growth of nearly all crops. The drouth early in the season was sufficiently severe to check the growth of grass and some garden crops, the hay crop being quite light.

The temperature for January was much below the average, while February and March were about normal. The spring opened quite early, April and May being mild and favorable for farm work. The last damaging frosts in the spring occurred on the 1st and 2d of May. The summer season was notable for several periods of extremely high temperature. Most farm crops except hay made a very fair growth. A light

frost occurred September 20th, and the first killing frost on September 24th, thus giving a growing period of 144 days after the last severe frost in the spring. The average growing season at this Station for the past eight years has been 145 days. The fall months were unusually wet, and unfavorable for harvesting corn.

Through the kindness of the New England Meteorological Society we are able to publish the rainfall records from twelve of their Stations in Connecticut.

Table 75 gives the rainfall as recorded for the six months ending October 31st for twenty localities in the State, and table 76 gives the summary of observations made by the Station at Storrs.

TABLE 75.

Rainfall during six months ending October 31, 1896.

LOCALITY.	OBSERVER.	INCHES PER MONTH.						
		May.	June.	July.	August.	September.	October.	Total.
Falls Village, -	M. H. Dean, -	3.39	2.53	6.67	4.25	6.25	3.10	26.19
Norwalk, - -	G. C. Comstock,* -	5.33	4.26	4.71	2.53	5.42	2.22	24.47
Bridgeport, - -	Wm. Jennings,* -	4.81	3.88	3.45	2.19	5.40	2.45	22.18
Waterbury, - -	N. J. Welton,* -	2.34	5.71	3.16	2.67	5.01	2.77	21.66
Canton, - -	G. J. Case,* - -	2.93	3.80	3.39	4.12	6.58	3.73	24.55
West Simsbury, -	S. T. Stockwell,* -	2.86	3.63	4.57	3.02	5.96	3.16	23.20
Southington, -	Lumen Andrews,* -	2.91	5.30	3.23	3.20	6.13	3.30	24.07
New Haven, -	Weather Bureau,* -	3.67	2.96	3.86	2.57	3.42	2.91	19.39
Newington, - -	J. S. Kirkham, -	2.62	5.41	2.39	3.04	2.85	3.85	20.16
Hartford, - -	Prof. S. Hart,* -	2.51	4.63	2.40	4.84	—	3.65	—
Vernon Centre, -	E. H. Lathrop, -	2.15	4.26	3.61	3.24	4.15	4.54	21.95
South Manchester,	K. B. Loomis, -	2.40	3.43	2.85	3.54	5.21	4.00	21.43
Middletown, -	C. W. Hubbard,* -	3.00	4.36	2.72	2.59	5.26	4.31	22.24
Madison, - -	J. D. Kelsey, -	4.09	3.25	4.35	3.37	5.34	3.57	23.97
New London, -	Weather Bureau,* -	2.17	1.72	3.64	3.60	2.49	3.37	16.99
Colchester, - -	S. P. Willard,* -	4.97	3.00	2.45	4.05	6.60	4.65	25.72
Lebanon, - -	E. A. Hoxie, -	4.49	3.48	2.26	6.86	6.26	—	—
North Franklin, -	C. H. Lathrop, -	5.52	2.29	1.59	3.70	4.58	3.62	21.30
Storrs, - - -	Experiment Station,	2.72	1.78	3.22	2.71	7.03	3.60	21.06
Voluntown, - -	Rev. C. Dewhurst,*	2.39	2.47	3.89	2.77	6.25	3.05	20.82
Average, - -	- - -	**3.35**	**3.60**	**3.42**	**3.44**	**5.22**	**3.47**	**22.30**

* New England Meteorological Society Observer.

TABLE 76.

Meteorological Summary for 1896.

OBSERVATIONS MADE AT STORRS BY THE STATION.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Mean.	Total.
Highest barometer,	30.52	30.48	30.56	30.53	30.37	30.35	30.34	30.33	30.38	30.57	30.81	30.90	30.51	—
Lowest barometer,	29.67	28.82	29.13	29.60	29.67	29.56	29.65	29.75	29.66	29.54	29.63	29.52	29.60	—
Mean barometer,	30.17	29.87	29.91	30.10	30.02	29.99	30.03	30.03	30.05	30.04	30.19	30.14	29.96	—
Highest temperature,	40.5	52.8	57.0	84.8	89.8	86.6	88.9	91.3	87.4	73.6	69.0	54.2	73.0	—
Lowest temperature,	—13.0	—13.3	5.5	23.2	31.1	40.9	51.6	44.0	34.0	24.8	16.8	—3.0	20.2	—
Mean temperature,	21.8	26.3	28.5	47.5	59.9	63.2	69.6	68.5	59.9	47.2	43.5	26.8	46.9	—
Relative humidity,	—	—	—	68.2	67.2	75.1	79.8	77.0	80.3	77.0	—	—	—	—
Total precipitation,	1.60	7.10	4.86	.80	2.72	1.78	3.22	2.71	7.03	3.60	2.49	2.67	—	40.58
Number of days with precipitation of .01 inch or more,	7	10	11	3	9	7	10	9	8	10	7	6	—	97
Number of clear days,	9	6	12	13	9	9	8	13	8	7	6	12	—	112
Number of fair days,	12	13	10	15	14	12	12	10	7	8	12	9	—	134
Number of cloudy days,	10	10	9	2	8	9	11	8	15	16	12	10	—	120
Total movement of wind in miles,	6863	9741	11805	6955	6253	5659	5339	4407	5959	6476	6205	7333	—	—
Maximum velocity of wind,	48	54	60	36	45	30	28	25	42	42	35	60	—	—

INDEX.

COMPOUND INDEX

TO THE REPORT OF THE BOARD OF AGRICULTURE, OF THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION, AND OF THE STORRS AGRICULTURAL EXPERIMENT STATION.

Star (*) refers to Connecticut Experiment Station, and dagger (†) to Storrs Experiment Station.

Page.